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the Child's Mind



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The remarkable physical transformation children undergo as they grow up is matched only by the metamorphosis of their minds. Parents, of course, play a critical role in this aspect of development. But what's really going on in a child's head? Kids can't always tell us what's on their minds. Psychologists, neurobiologists and other scientists can help fill in the blanks, however.

In this exclusive online issue, leading authorities share their insights into the minds of the young. Learn how children develop morals, why they talk to themselves, and what happens to brain development and function in the face of abuse at an early age. Other articles explore how reading should be taught, how attention-deficit hyperactivity disorder arises and what unique challenges gifted children face. Lastly, sharpen your little one's powers of concentration--and your own--with a few easy tricks.—*The Editors*

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The Moral Development of Children

originally published in August 1999

*It is not enough for kids to tell right from wrong.
They must develop a commitment to acting on their ideals.
Enlightened parenting can help*

by William Damon

With unsettling regularity, news reports tell us of children wreaking havoc on their schools and communities: attacking teachers and classmates, murdering parents, persecuting others out of viciousness, avarice or spite. We hear about feral gangs of children running drugs or numbers, about teenage date rape, about youthful vandalism, about epidemics of cheating even in academically elite schools. Not long ago a middle-class gang of youths terrorized an affluent California suburb through menacing threats and extortion, proudly awarding themselves points for each antisocial act. Such stories make *Lord of the Flies* seem eerily prophetic.

What many people forget in the face of this grim news is that most children most of the time do follow the rules of their society, act fairly, treat friends kindly, tell the truth and respect their elders. Many youngsters do even more. A large portion of young Americans volunteer in community service—according to one survey, between 22 and 45 percent, depending on the location. Young people have also been leaders in social causes. Harvard University psychiatrist Robert Coles has written about children such as Ruby, an African-American girl who broke the color barrier in her school during the 1960s. Ruby's daily walk into the all-white school demonstrated a brave sense of moral purpose. When taunted by classmates, Ruby prayed for their redemption rather than cursing them. "Ruby," Coles observed, "had a will and used it to make an ethical choice; she demonstrated moral

The Six Stages of Moral Judgment

Growing up, children and young adults come to rely less on external discipline and more on deeply held beliefs. They go through as many as six stages (grouped into three levels) of moral reasoning, as first argued by psychologist Lawrence Kohlberg in the late 1950s (*below*). The evidence includes a long-term study of 58 young men interviewed periodically over two decades. Their moral maturity was judged by how they analyzed hypothetical dilemmas, such as whether a husband should steal a drug for his dying wife. Either yes or no was a valid answer; what mattered was how the men justified it. As they grew up, they passed through the stages in succession, albeit at different rates (*bar graph*). The sixth stage remained elusive. Despite the general success of this model for describing intellectual growth, it does not explain people's actual behavior. Two people at the same stage may act differently. —W.D.

LEVEL 1: SELF-INTEREST

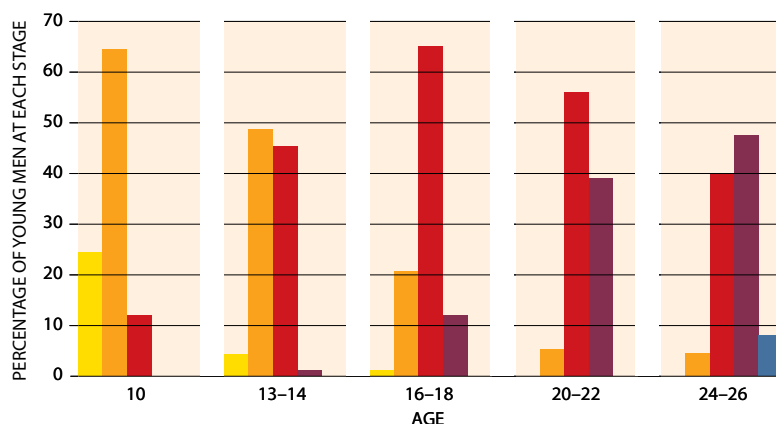
- STAGE 1 PUNISHMENT "I won't do it, because I don't want to get punished."
- STAGE 2 REWARD "I won't do it, because I want the reward."

LEVEL 2: SOCIAL APPROVAL

- STAGE 3 INTERPERSONAL RELATIONS "I won't do it, because I want people to like me."
- STAGE 4 SOCIAL ORDER "I won't do it, because it would break the law."

LEVEL 3: ABSTRACT IDEALS

- STAGE 5 SOCIAL CONTRACT "I won't do it, because I'm obliged not to."
- STAGE 6 UNIVERSAL RIGHTS "I won't do it, because it's not right, no matter what others say."



EDWARD BELL; SOURCE: ANNE COLBY, Carnegie Foundation for the Advancement of Teaching

stamina; she possessed honor, courage."

All children are born with a running start on the path to moral development. A number of inborn responses predispose them to act in ethical ways. For example, empathy—the capacity to experience another person's pleasure or pain vicariously—is part of our native endowment as humans. Newborns cry when they hear others cry and show signs of pleasure at happy sounds such as cooing and laughter. By the second year of life, children commonly console peers or parents in distress.

Sometimes, of course, they do not quite know what comfort to provide. Psychologist Martin L. Hoffman of New York University once saw a toddler of-

fering his mother his security blanket when he perceived she was upset. Although the emotional disposition to help is present, the means of helping others effectively must be learned and refined through social experience. Moreover, in many people the capacity for empathy stagnates or even diminishes. People can act cruelly to those they refuse to empathize with. A New York police officer once asked a teenage thug how he could have crippled an 83-year-old woman during a mugging. The boy replied, "What do I care? I'm not her."

A scientific account of moral growth must explain both the good and the bad. Why do most children act in reasonably—sometimes exceptionally—

moral ways, even when it flies in the face of their immediate self-interest? Why do some children depart from accepted standards, often to the great harm of themselves and others? How does a child acquire mores and develop a lifelong commitment to moral behavior, or not?

Psychologists do not have definitive answers to these questions, and often their studies seem merely to confirm parents' observations and intuition. But parents, like all people, can be led astray by subjective biases, incomplete information and media sensationalism. They may blame a relatively trivial event—say, a music concert—for a deep-seated problem such as drug dependency. They may incorrectly attribute their own problems to a strict upbringing and then try to compensate by raising their children in an overly permissive way. In such a hotly contested area as children's moral values, a systematic, scientific approach is the only way to avoid wild swings of emotional reaction that end up repeating the same mistakes.

The Genealogy of Morals

The study of moral development has become a lively growth industry within the social sciences. Journals are full of new findings and competing models. Some theories focus on natural biological forces; others stress social influence and experience; still others, the judgment that results from children's intellectual development. Although each theory has a different emphasis, all recognize that no single cause can account for either moral or immoral behavior. Watching violent videos or playing shoot-'em-up computer games may push some children over the edge and leave others unaffected. Conventional wisdom dwells on lone silver bullets, but scientific understanding must be built on an appreciation of the complexity and variety of children's lives.

Biologically oriented, or "nativist," theories maintain that human morality springs from emotional dispositions that are hardwired into our species. Hoffman, Colwyn Trevarthen of the University of Edinburgh and Nancy Eisenberg of Arizona State University have established that babies can feel empathy as soon as they recognize the existence of others—sometimes in the first week after

birth. Other moral emotions that make an early appearance include shame, guilt and indignation. As Harvard child psychologist Jerome S. Kagan has described, young children can be outraged by the violation of social expectations, such as a breach in the rules of a favorite game or rearranged buttons on a piece of familiar clothing.

Nearly everybody, in every culture, inherits these dispositions. Mary D. Ainsworth of the University of Virginia reported empathy among Ugandan and American infants; Norma Feshbach of the University of California at Los Angeles conducted a similar comparison of newborns in Europe, Israel and the U.S.; Millard C. Madsen of U.C.L.A. studied sharing by preschool children in nine cultures. As far as psychologists know, children everywhere start life with caring feelings toward those close to them and adverse reactions to inhumane or unjust behavior. Differences in how these reactions are triggered and expressed emerge only later, once children have been exposed to the particular value systems of their cultures.

In contrast, the learning theories concentrate on children's acquisition of behavioral norms and values through observation, imitation and reward. Research in this tradition has concluded that moral behavior is context-bound, varying from situation to situation almost independently of stated beliefs. Landmark studies in the 1920s, still frequently cited, include Hugh Hartshorne and Mark May's survey of how children reacted when given the chance to cheat. The children's behavior depended largely on whether they thought they would be caught. It could be predicted neither from their conduct in previous situations nor from their knowledge of common moral rules, such as the Ten Commandments and the Boy Scout's code.

Later reanalyses of Hartshorne and May's data, performed by Roger Burton of the State University of New York at Buffalo, discovered at least one general trend: younger children were more likely to cheat than adolescents. Perhaps socialization or mental growth can restrain dishonest behavior after all. But the effect was not a large one.

The third basic theory of moral development puts the emphasis on intellectual growth, arguing that virtue and vice are ultimately a matter of conscious choice. The best-known cognitive theories are those of psychologists Jean Piaget and Lawrence Kohlberg. Both de-

scribed children's early moral beliefs as oriented toward power and authority. For young children, might makes right, literally. Over time they come to understand that social rules are made by people and thus can be renegotiated and that reciprocity in relationships is more fair than unilateral obedience. Kohlberg identified a six-stage sequence in the maturation of moral judgment. Several thousand studies have used it as a measure of how advanced a person's moral reasoning is.

Conscience versus Chocolate

Although the main parts of Kohlberg's sequence have been confirmed, notable exceptions stand out. Few if any people reach the sixth and most ad-

vanced stage, in which their moral view is based purely on abstract principles. As for the early stages in the sequence, many studies (including ones from my own laboratory) have found that young children have a far richer sense of positive morality than the model indicates. In other words, they do not act simply out of fear of punishment. When a playmate hogs a plate of cookies or refuses to relinquish a swing, the protest "That's not fair!" is common. At the same time, young children realize that they have an obligation to share with others—even when their parents say not to. Preschool children generally believe in an equal distribution of goods and back up their beliefs with reasons such as empathy ("I want my friend to feel nice"), reciprocity ("She shares her toys with

"Could You Live with Yourself?"

In a distressed neighborhood in Camden, N.J., social psychologist Daniel Hart of Rutgers University interviewed an African-American teenager who was active in community service:

How would you describe yourself?

I am the kind of person who wants to get involved, who believes in getting involved. I just had this complex, I call it, where people think of Camden as being a bad place, which bothered me. Every city has its own bad places, you know. I just want to work with people, work to change that image that people have of Camden. You can't start with adults, because they don't change. But if you can get into the minds of young children, show them what's wrong and let them know that you don't want them to be this way, then it could work, because they're more persuadable.

Is there really one correct solution to moral problems like this one?

Basically, it's like I said before. You're supposed to try to help save a life.

How do you know?

Well, it's just—how could you live with yourself? Say that I could help save this person's life—could I just let that person die? I mean, I couldn't live with myself if that happened. A few years ago my sister was killed, and ... the night she was killed I was over at her house, earlier that day. Maybe if I had spent the night at her house that day, maybe this wouldn't have happened.

You said that you're not a bad influence on others. Why is that important?

Well, I try not to be a bad role model. All of us have bad qualities, of course; still, you have to be a role model even if you're a person walking down the street. You know, we have a society today where there are criminals and crooks. There are drug users. Kids look to those people. If they see a drug dealer with a lot of money, they want money, too, and then they're going to do drugs. So it's important that you try not to be a bad influence, because that can go a long way. Even if you say, oh, wow, you tell your little sister or brother to be quiet so Mom and Dad won't wake so you won't have to go to school. And they get in the habit of being quiet [*laughs*], your not going to school, things like that. So when you're a bad influence, it always travels very far.

Why don't you want that to happen?

Because in today's society there's just really too much crime, too much violence. I mean everywhere. And I've even experienced violence, because my sister was murdered. You know, we need not to have that in future years, so we need to teach our children otherwise.

me”) and egalitarianism (“We should all get the same”). All this they figure out through confrontation with peers at play. Without fairness, they learn, there will be trouble.

In fact, none of the three traditional theories is sufficient to explain children’s moral growth and behavior. None captures the most essential dimensions of moral life: character and commitment. Regardless of how children develop their initial system of values, the key question is: What makes them live up to their ideals or not? This issue is the fo-

cus of recent scientific thinking.

Like adults, children struggle with temptation. To see how this tug of war plays itself out in the world of small children, my colleagues and I (then at Clark University) devised the following experiment. We brought groups, each of four children, into our lab, gave them string and beads, and asked them to make bracelets and necklaces for us. We then thanked them profusely for their splendid work and rewarded them, as a group, with 10 candy bars. Then the real experiment began: we told each group

that it would need to decide the best way to divide up the reward. We left the room and watched through a one-way mirror.

Before the experiment, we had interviewed participants about the concept of fairness. We were curious, of course, to find out whether the prospect of gobbling up real chocolate would overwhelm their abstract sense of right and wrong. To test this thoroughly, we gave one unfortunate control group an almost identical conundrum, using cardboard rectangles rather than real chocolate—a not so subtle way of defusing

How Universal Are Values?

The observed importance of shared values in children’s moral development raises some of the most hotly debated questions in philosophy and the social sciences today. Do values vary from place to place, or is there a set of universal values that guides moral development everywhere? Do children growing up in different cultures or at different times acquire fundamentally different mores?

Some light was shed on the cultural issue by Richard A. Shweder of the University of Chicago and his colleagues in a study of Hindu-Brahmin children in India and children from Judeo-Christian backgrounds in the U.S. The study revealed striking contrasts between the two groups. From an early age, the Indian children learned to maintain tradition, to respect defined rules of interpersonal relationships and to help people in need. American children, in comparison, were oriented toward autonomy, liberty and personal rights. The Indian children said that breaches of tradition, such as eating beef or addressing one’s father by his first name, were particularly reprehensible. They saw nothing wrong with a man caning his errant son or a husband beating his wife when she went to the movies without his permission. The American children were appalled by all physically punitive behavior but indifferent to infractions such as eating forbidden foods or using improper forms of address.

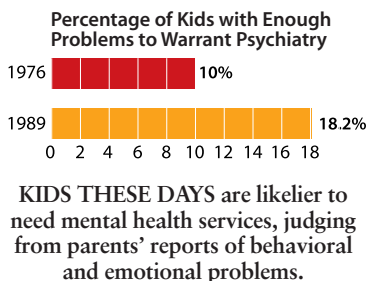
Moreover, the Indians and Americans moved in opposite directions as they matured. Whereas Indian children restricted value judgments to situations with which they were directly familiar, Indian adults generalized their values to a broad range of social conditions. American children said that moral standards should apply to everyone always; American adults modified values in the face of changing circumstances. In short, the Indians began life as relativists and ended up as universalists, whereas the Americans went precisely the other way.

It would be overstating matters, however, to say that children from different cultures adopt completely different moral codes. In Shweder’s study, both groups of children thought that deceitful acts (a father breaking a promise to a child) and uncharitable acts (ignoring a beggar with a sick child) were wrong. They also shared a repugnance toward theft, vandalism and harming innocent victims, although there was some disagreement on what constitutes inno-

cence. Among these judgments may be found a universal moral sense, based on common human aversions. It reflects core values—benevolence, fairness, honesty—that may be necessary for sustaining human relationships in all but the most dysfunctional societies.

A parallel line of research has studied gender differences, arguing that girls learn to emphasize caring, whereas boys incline toward rules and justice. Unlike the predictions made by culture theory, however, these gender claims have not held up. The original research that claimed to find gender differences lacked proper control groups. Well-designed studies of American children—for example, those by Lawrence Walker of the University of British Columbia—rarely detect differences between boys’ and girls’ ideals. Even for adults, when educational or occupational levels are controlled, the differences disappear. Female lawyers have almost the same moral orientations as their male counterparts; the same can be said for male and female nurses, homemakers, scientists, high school dropouts and so on. As cultural theorists point out, there is far more similarity between male and female moral orientations within any given culture than between male and female orientations across cultures.

Generational differences are also of interest, especially to people who bemoan what they see as declining morality. Such complaints, of course, are nothing new [see “Teenage Attitudes,” by H. H. Remmers and D. H. Radler; *SCIENTIFIC AMERICAN*, June 1958; and “The Origins of Alienation,” by Urie Bronfenbrenner; *SCIENTIFIC AMERICAN*, August 1974]. Nevertheless, there is some evidence that young people today are more likely to engage in antisocial behavior than those a generation ago were. According to a survey by Thomas M. Achenbach and Catherine T. Howell of the University of Vermont, parents and teachers reported more behavioral problems (lying, cheating) and other threats to healthy development (depression, withdrawal) in 1989 than in 1976 (above). (The researchers are now updating their survey.) But in the long sweep of human history, 13 years is merely an eye blink. The changes could reflect a passing problem, such as overly permissive fashions in child rearing, rather than a permanent trend. —W.D.



their self-interest. We observed groups of four-, six-, eight- and 10-year-old children to see whether the relationship between situational and hypothetical morality changed with age.

The children's ideals did make a difference but within limits circumscribed by narrow self-interest. Children given cardboard acted almost three times more generously toward one another than did children given chocolate. Yet moral beliefs still held some sway. For example, children who had earlier expressed a belief in merit-based solutions ("The one who did the best job should get more of the candy") were the ones most likely to advocate for merit in the real situation. But they did so most avidly when they themselves could claim to have done more than their peers. Without such a claim, they were easily persuaded to drop meritocracy for an equal division.

Even so, these children seldom abandoned fairness entirely. They may have switched from one idea of justice to another—say, from merit to equality—but they did not resort to egoistic justifications such as "I should get more because I'm big" or "Boys like candy more than girls, and I'm a boy." Such rationales generally came from children who had declared no belief in either equality or meritocracy. Older children were more likely to believe in fairness and to act accordingly, even when such action favored others. This finding was evidence for the reassuring proposition that ideals can have an increasing influence on conduct as a child matures.

Do the Right Thing

But this process is not automatic. A person must adopt those beliefs as a central part of his or her personal identity. When a person moves from saying "People should be honest" to "I want to be honest," he or she becomes more likely to tell the truth in everyday interactions. A person's use of moral principles to define the self is called the person's moral identity. Moral identity determines not merely what the person considers to be the right course of action but also why he or she would decide: "I myself must take this course." This distinction is crucial to understanding the variety of moral behavior. The same basic ideals are widely shared by even the youngest members of society; the difference is the resolve to act on those ideals.

Most children and adults will express the belief that it is wrong to allow oth-

ers to suffer, but only a subset of them will conclude that they themselves must do something about, say, ethnic cleansing in Kosovo. Those are the ones who are most likely to donate money or fly to the Balkans to help. Their concerns about human suffering are central to the way they think about themselves and their life goals, and so they feel a responsibility to take action, even at great personal cost.

In a study of moral exemplars—people with long, publicly documented histories of charity and civil-rights work—psychologist Anne Colby of the Carnegie Foundation and I encountered a high level of integration between self-identity and moral concerns. "People who define themselves in terms of their moral goals are likely to see moral problems in everyday events, and they are also likely to see themselves as necessarily implicated in these problems," we wrote. Yet the exemplars showed no signs of more insightful moral reasoning. Their ideals and Kohlberg levels were much the same as everyone else's.

Conversely, many people are equally aware of moral problems, but to them the issues seem remote from their own lives and their senses of self. Kosovo and Rwanda sound far away and insignificant; they are easily put out of mind. Even issues closer to home—say, a maniacal clique of peers who threaten a classmate—may seem like someone else's problem. For people who feel this way, inaction does not strike at their self-conception. Therefore, despite commonplace assumptions to the contrary, their moral knowledge will not be enough to impel moral action.

The development of a moral identity follows a general pattern. It normally takes shape in late childhood, when children acquire the capacity to analyze people—including themselves—in terms of stable character traits. In childhood, self-identifying traits usually consist of action-related skills and interests ("I'm smart" or "I love music"). With age, children start to use moral terms to define themselves. By the onset of puberty, they typically invoke adjectives such as "fair-minded," "generous" and "honest."

Some adolescents go so far as to describe themselves primarily in terms of moral goals. They speak of noble purposes, such as caring for others or improving their communities, as missions that give meaning to their lives. Working in Camden, N.J., Daniel Hart and his colleagues at Rutgers University found

that a high proportion of so-called care exemplars—teenagers identified by teachers and peers as highly committed to volunteering—had self-identities that were based on moral belief systems. Yet they scored no higher than their peers on the standard psychological tests of moral judgment. The study is noteworthy because it was conducted in an economically deprived urban setting among an adolescent population often stereotyped as high risk and criminally inclined [see box on page 4].

At the other end of the moral spectrum, further evidence indicates that moral identity drives behavior. Social psychologists Hazel Markus of Stanford University and Daphne Oyserman of the University of Michigan have observed that delinquent youths have immature senses of self, especially when talking about their future selves (a critical part of adolescent identity). These troubled teenagers do not imagine themselves as doctors, husbands, voting citizens, church members—any social role that embodies a positive value commitment.

How does a young person acquire, or not acquire, a moral identity? It is an incremental process, occurring gradually in thousands of small ways: feedback from others; observations of actions by others that either inspire or appall; reflections on one's own experience; cultural influences such as family, school, religious institutions and the mass media. The relative importance of these factors varies from child to child.

Teach Your Children Well

For most children, parents are the original source of moral guidance. Psychologists such as Diana Baumrind of the University of California at Berkeley have shown that "authoritative" parenting facilitates children's moral growth more surely than either "permissive" or "authoritarian" parenting. The authoritative mode establishes consistent family rules and firm limits but also encourages open discussion and clear communication to explain and, when justified, revise the rules. In contrast, the permissive mode avoids rules entirely; the authoritarian mode irregularly enforces rules at the parent's whim—the "because I said so" approach.

Although permissive and authoritarian parenting seem like opposites, they actually tend to produce similar patterns of poor self-control and low social responsibility in children. Neither

mode presents children with the realistic expectations and structured guidance that challenge them to expand their moral horizons. Both can foster habits—such as feeling that mores come from the outside—that could inhibit the development of a moral identity. In this way, moral or immoral conduct during adulthood often has roots in childhood experience.

As children grow, they are increasingly exposed to influences beyond the family. In most families, however, the parent-child relationship remains primary as long as the child lives at home. A parent's comment on a raunchy music lyric or a blood-drenched video usually will stick with a child long after the media experience has faded. In fact, if salacious or violent media programming opens the door to responsible parental feedback, the benefits can far outweigh the harm.

One of the most influential things parents can do is to encourage the right kinds of peer relations. Interactions with peers can spur moral growth by showing children the conflict between their preconceptions and social reality. During the debates about dividing the chocolate, some of our subjects seemed to pick up new—and more informed—ideas about justice. In a follow-up study, we confirmed that the peer debate had heightened their awareness of the rights of others. Children who participated actively in the debate, both expressing their opinions and listening to the viewpoints of others, were especially likely to benefit.

In adolescence, peer interactions are crucial in forging a self-identity. To be sure, this process often plays out in cliquish social behavior: as a means of defining and shoring up the sense of self, kids will seek out like-minded peers and

spurn others who seem foreign. But when kept within reasonable bounds, the in-group clustering generally evolves into a more mature friendship pattern. What can parents do in the meantime to fortify a teenager who is bearing the brunt of isolation or persecution? The most important message they can give is that cruel behavior reveals something about the perpetrator rather than about the victim. If this advice helps the youngster resist taking the treatment personally, the period of persecution will pass without leaving any psychological scars.

Some psychologists, taking a sociological approach, are examining community-level variables, such as whether various moral influences—parents, teachers, mass media and so on—are consistent with one another. In a study of 311 adolescents from 10 American towns and cities, Francis A. J. Ianni of the Columbia University Teachers College noticed high degrees of altruistic behavior and low degrees of antisocial behavior among youngsters from communities where there was consensus in expectations for young people.

Everyone in these places agreed that honesty, for instance, is a fundamental value. Teachers did not tolerate cheating on exams, parents did not let their children lie and get away with it, sports coaches did not encourage teams to bend the rules for the sake of a win, and people of all ages expected openness from their friends. But many communities were divided along such lines. Coaches espoused winning above all else, and parents protested when teachers reprimanded their children for cheating or shoddy schoolwork. Under such circumstances, children learned not to take moral messages seriously.

Ianni named the set of shared stan-

dards in harmonious communities a “youth charter.” Ethnicity, cultural diversity, socioeconomic status, geographic location and population size had nothing to do with whether a town offered its young people a steady moral compass. The notion of a youth charter is being explored in social interventions that foster communication among children, parents, teachers and other influential adults. Meanwhile other researchers have sought to understand whether the specific values depend on cultural, gender or generational background [see box on page 5].

Unfortunately, the concepts embodied in youth charters seem ever rarer in American society. Even when adults spot trouble, they may fail to step in. Parents are busy and often out of touch with the peer life of their children; they give kids more autonomy than ever before, and kids expect it—indeed, demand it. Teachers, for their part, feel that a child's nonacademic life is none of their business and that they could be censured, even sued, if they intervened in a student's personal or moral problem. And neighbors feel the same way: that they have no business interfering with another family's business, even if they see a child headed for trouble.

Everything that psychologists know from the study of children's moral development indicates that moral identity—the key source of moral commitment throughout life—is fostered by multiple social influences that guide a child in the same general direction. Children must hear the message enough for it to stick. The challenge for pluralistic societies will be to find enough common ground to communicate the shared standards that the young need. SA

The Author

WILLIAM DAMON remembers being in an eighth-grade clique that tormented an unpopular kid. After describing his acts in the school newspaper, he was told by his English teacher, “I give you an A for the writing, but what you're doing is really shameful.” That moral feedback has stayed with him. Damon is now director of the Center on Adolescence at Stanford University, an interdisciplinary program that specializes in what he has called “the least understood, the least trusted, the most feared and most neglected period of development.” A developmental psychologist, he has studied intellectual and moral growth, educational methods, and peer and cultural influences on children. He is the author of numerous books and the father of three children, the youngest now in high school.

Further Reading

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Why Children Talk to Themselves

Although children are often rebuked for talking to themselves out loud, doing so helps them control their behavior and master new skills

by Laura E. Berk

originally published in November 1994

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As any parent, teacher, sitter or casual observer will notice, young children talk to themselves—sometimes as much or even more than they talk to other people. Depending on the situation, this private speech (as modern psychologists call the behavior) can account for 20 to 60 percent of the remarks a child younger than 10 years makes. Many parents and educators misinterpret this chatter as a sign of disobedience, inattentiveness or even mental instability. In fact, private speech is an essential part of cognitive development for all children. Recognition of this fact should strongly influence how both normal children and children who have trouble learning are taught.

Although private speech has presumably been around as long as language itself, the political climate in Russia in the 1930s, and the authority of a great Western cognitive theorist, prevented psychologists and educators from understanding its significance until only very recently. In Russia more than six decades ago, Lev S. Vygotsky, a prominent psychologist, first documented the importance of private speech. But at that time, the Stalinist regime systematically persecuted many intellectuals, and

purges at universities and research institutes were common.

In fear, Soviet psychologists turned on one another. Some declared Vygotsky a renegade, and several of his colleagues and students split from his circle. According to the recollections of one of Vygotsky's students, the Communist party scheduled a critical "discussion" in which Vygotsky's ideas would be the major target. But in 1934, before Vygotsky could replicate and extend his preliminary studies or defend his position to the party, he died of tuberculosis. Two years later the Communist party banned his published work.

In addition to not knowing about Vygotsky, Western psychologists and educators were convinced by the eminent Swiss theorist Jean Piaget that private speech plays no positive role in normal cognitive development. In the 1920s, even before Vygotsky began his inquiries, Piaget had completed a series of seminal studies in which he carefully recorded the verbalizations of three- to seven-year-olds at the J. J. Rousseau Institute of the University of Geneva. Besides social remarks, Piaget identified three additional types of utterances that were not easily understood or clearly

addressed to a listener: the children repeated syllables and sounds playfully, gave soliloquies and delivered what Piaget called collective monologues.

Piaget labeled these three types of speech egocentric, expressing his view that they sprang only from immature minds. Young children, he reasoned, engage in egocentric speech because they have difficulty imagining another's perspective. Much of their talk then is talk for themselves and serves little communicative function. Instead it merely accompanies, supplements or reinforces motor activity or takes the form of non sequiturs: one child's verbalization stimulates speech in another, but the partner is expected neither to listen nor understand. Piaget believed private speech gradually disappears as children become capable of real social interaction.

Although several preschool teachers and administrators openly questioned Piaget's ideas, he had the last word until Vygotsky's work reached the West in the 1960s. Three years after Joseph Stalin's death in 1953, Nikita S. Khrushchev criticized Stalin's "rule by terror" and announced in its place a policy that encouraged greater intellectual freedom. The 20-year ban on Vygotsky's writings came to an end. In 1962 an English translation of Vygotsky's collection of essays, *Thought and Language*, appeared in the U.S. Within less than a decade, a team led by Lawrence Kohlberg of Harvard University had com-

piled provocative evidence in support of Vygotsky's ideas.

In the late 1970s some American psychologists were becoming disenchanted with Piaget's theory, and at the same time, a broader range of Vygotsky's writings appeared in English. These conditions, coupled with Kohlberg's results, inspired a flurry of new investigations. Indeed, since the mid-1980s the number of studies done on private speech in the West has increased threefold. Most of these studies, including my own, corroborate Vygotsky's views.

In his papers Vygotsky described a strong link between social experience, speech and learning. According to the Russian, the aspects of reality a child is ready to master lie within what he called the zone of proximal (or potential) development. It refers to a range of tasks that the child cannot yet accomplish without guidance from an adult or more skilled peer. When a child discusses a challenging task with a mentor, that individual offers spoken directions and strategies. The child incorporates the language of those dialogues into his or her private speech and then uses it to guide independent efforts.

"The most significant moment in the course of intellectual development," Vygotsky wrote, "...occurs when speech and practical activity, two previously completely independent lines of development, converge." The direction of development, he argued, is not one in

which social communication eventually replaces egocentric utterances, as Piaget had claimed. Instead Vygotsky proposed that early social communication precipitates private speech. He maintained that social communication gives rise to all uniquely human, higher cognitive processes. By communicating with mature members of society, children learn to master activities and think in ways that have meaning in their culture.

As the child gains mastery over his or her behavior, private speech need not occur in a fully expanded form; the self, after all, is an extremely understanding listener. Consequently, children omit words and phrases that refer to things they already know about a given situation. They state only those aspects that still seem puzzling. Once their cognitive operations become well practiced, children start to "think words" rather than saying them. Gradually, private speech becomes internalized as silent, inner speech—those conscious dialogues we hold with ourselves while thinking and acting. Nevertheless, the need to engage in private speech never disappears. Whenever we encounter unfamiliar or demanding activities in our lives, private speech resurfaces. It is a tool that helps us overcome obstacles and acquire new skills.

Currently two American research programs, my own and that of Rafael M. Diaz at Stanford

Varieties of Private Speech

CATEGORY	DESCRIPTION	EXAMPLE
Egocentric Communication	Remarks directed to another that make no sense from the listener's perspective.	David says to Mark, who is sitting next to him on the rug, "It broke," without explaining what or when.
Fantasy Play	A child role-plays and talks to objects or creates sound effects for them.	Jay snaps, "Out of my way!" to a chair after he bumps into it.
Emotional Release	Comments not directed to a listener that express feelings, or those that seem to be attempts to review feelings about past events or thoughts.	Rachel is sitting at her desk with an anxious look on her face, repeating to herself, "My mom's sick, my mom's sick."
Self-Direction	A child describes the task at hand and gives himself or herself directions out loud.	Carla, while doing a page in her math book, says out loud, "Six." Then, counting on her fingers, she continues, "Seven, eight, nine, 10. It's 10, it's 10. The answer's 10."
Reading Aloud	A child reads written material aloud or sounds out words.	"Sher-lock Holm-lock, Sherlock Holme," Tommy reads, leaving off the final "s" in his second, more successful attempt.
Inaudible Muttering	Utterances so quiet that an observer cannot understand them.	Angela mumbles inaudibly to herself as she works on a math problem.

University, have sought to confirm and build on Vygotsky's findings. Our respective efforts began with similar questions: Do all children use private speech? Does it help them guide their actions? And does it originate in social communication? To find out, I chose to observe children in natural settings at school; Diaz selected the laboratory.

Ruth A. Garvin, one of my graduate students, and I followed 36 low-income Appalachian five- to 10-year-olds, who attended a mission school in the mountains of eastern Kentucky. We recorded speech in the classroom, on the playground, in the halls and in the lunchroom throughout the day—paying special attention to those remarks not specifically addressed to a listener.

Our findings revealed that egocentric speech, Piaget's focus, seldom occurred. Most of the comments we heard either described or served to direct a child's actions, consistent with the assumption that self-guidance is the central function of private speech. Moreover, the children talked to themselves more often when working alone on challenging tasks and also when their teachers were not immediately available to help them. In either case, the children needed to take charge of their own behavior.

Furthermore, we found evidence suggesting that private speech develops similarly in all children and that it arises in social experience. The private speech of the Appalachian students changed as they grew older in ways that were much like those patterns Kohlberg had reported a decade and a half earlier.

Middle-class children, such as those Kohlberg observed, speak out loud to themselves with increasing frequency between four and six years of age. Then, during elementary school, their private speech takes the form of inaudible muttering. The Appalachian children moved through this same sequence but did so more slowly. At age 10, more than 40 percent of their private speech remained highly audible, whereas Kohlberg's 10-year-olds spoke out loud to themselves less than 7 percent of the time.

To explain the difference, we studied Appalachian culture and made a striking discovery. Whereas middle-class parents frequently converse with their children, Appalachian parents do so much less often. Moreover, they usually rely more on gestures than on words. If Vygotsky's theory is correct, that private speech stems from social communication, then this taciturn home environment might explain the slow development of private speech in Appalachian children.

While our Appalachian study was un-

der way, Diaz and one of his graduate students, Marnie H. Frauenglass, videotaped 32 three- to six-year-olds in the laboratory as the youngsters matched pictures and solved puzzles. Frauenglass and Diaz also found that private speech becomes less audible with age. Yet their results, along with those of other researchers, posed serious challenges to Vygotsky's theory. First, many children emitted only a few utterances, and some none at all—seeming proof that private speech is not universal.

Another difficulty arose. If private speech facilitates self-regulation, as Vygotsky believed, then it should relate to how a child behaves while working and how well the child performs. Yet in Frauenglass and Diaz's study, children who used more private speech did worse on the tasks set before them! Other researchers had reported weak and sometimes negative associations between private speech and performance as well.

Diaz crafted some insightful explanations for these outcomes. After a close look at Vygotsky's definition of the zone of proximal development, Diaz concluded that perhaps the tasks typically given in the laboratory were not suitable for evoking private speech in all children. Some children may have been so familiar with solving puzzles and matching pictures that the cognitive operations they needed to succeed were already automatic. Other children may have found these tasks so difficult that they could not master them without help. In either case, self-guiding private speech would not be expected. Furthermore, Diaz reasoned that since private speech increases when children encounter difficulties, it would often coincide with task failure. He suggested that the beneficial impact of private speech might be delayed.

Returning to the classroom—this time, to the laboratory school at Illinois State University—I embarked on a series of studies to test these intriguing possibilities. My team of observers carefully recorded the private speech and task-related actions of 75 first to third graders as they worked alone at their desks on math problems. Their teachers considered this work to be appropriately challenging for each child. Graduate student Jennifer A. Bivens and I then followed the first graders and monitored their behavior as second and third graders.

Every child we observed talked to himself or herself—on average 60 percent of the time. Also, as in previous studies, many children whose remarks described or otherwise commented on

their activity received lower scores on homework and achievement tests taken that same year. Yet private speech that was typical for a particular age predicted gains in math achievement over time. Specifically, first graders who made many self-guiding comments out loud or quietly did better at second-grade math. Likewise, second graders who often muttered to themselves grasped third-grade math more easily the following year.

Also, the relationship we noted between a child's use of private speech and his or her task-related behavior bolstered Vygotsky's hypothesis that self-guiding comments help children direct their actions. Children whose speech included a great deal of task-irrelevant wordplay or emotional expression often squirmed in their seats or chewed on or tapped their pencils against their desks.

In contrast, children who frequently made audible comments about their work used more nonverbal techniques to help them overcome difficulties, such as counting on fingers or tracking a line of text using a pencil. Finally, children who most often used quiet private speech rarely fidgeted and were highly attentive. Overall, children who progressed most rapidly from audible remarks to inner speech were more advanced in their ability to control motor activity and focus attention. The development of private speech and task-related behavior thus went hand in hand.

In a later investigation, Sarah T. Spuhl, another of my graduate students, and I attempted to witness in the laboratory the dynamic relationship Vygotsky highlighted between private speech and learning—namely, private speech diminishes as performance improves. We added a new dimension to our research as well: an exploration of how the interaction between a child and an adult can foster self-regulation through private speech.

We asked 30 four- and five-year-olds to assemble Lego pieces into a reproduction of a model. Each subject attempted the exercise in three 15-minute sessions, scheduled no more than two to four days apart. This timing permitted us to track their increasing competence. We pretested each child to ensure that the Lego tasks would be sufficiently challenging—something that had not been done before. Only novice Lego builders participated. Two weeks before the sessions began, we videotaped each mother helping her child with activities that required skills similar to those involved in Lego building, such as fitting blocks together and matching their colors and shapes.



Next we evaluated the communication between the mothers and their children as they solved problems together. According to previous research, parenting that is warm and responsive but exerts sufficient control to guide and encourage children to acquire new skills promotes competence. (Psychologists term such parenting authoritative.) In contrast, both authoritarian parenting (little warmth and high control) and permissive parenting (high warmth and little control) predict learning and adjustment problems. Based on this evidence, we thought that the authoritative style might best capture those features of adult teaching we wished to identify.

Our results revealed that children who have authoritative mothers more often used self-guiding private speech. Among the four-year-olds, those experiencing authoritative teaching showed greater improvement in skill over the course of the three Lego-building sessions. Furthermore, we did a special statistical analysis, the outcome of which suggested that private speech mediates

the relationship between authoritative parenting and task success—a finding consistent with Vygotsky's assumptions.

Unlike previous laboratory research, every child in our sample used private speech. As expected, the children's comments became more internalized over the course of the three sessions as their skill with the Lego blocks increased. And once again, private speech predicted future gains better than it did concurrent task success. In particular, children who used private speech that was appropriate for their age—audible, self-guiding utterances at age four and inaudible muttering at age five—achieved the greatest gains.

Next I turned my attention to children having serious learning and behavior problems. Many psychologists had concluded that elementary school pupils who were inattentive, impulsive or had learning disabilities suffered from deficits in using private speech. To treat these children, researchers had designed and widely implemented training programs

aimed at inducing children to talk to themselves. In a typical program, children are asked to mimic a therapist acting out self-guiding private speech while performing a task. Next the therapist demonstrates lip movements only and finally asks the children to verbalize covertly.

Despite the intuitive appeal of this training, the approach most often failed. I suspected that the design of these treatments might have been premature. The procedures were not grounded in systematic research on how children having learning and behavior problems use private speech. The spontaneous self-regulatory utterances of such children remained largely uninvestigated.

To fill this gap in our knowledge, my graduate student Michael K. Potts and I studied 19 six- to 12-year-old boys who had been clinically diagnosed with attention-deficit hyperactivity disorder (ADHD), a condition characterized by severe inattentiveness, impulsivity and overactivity. Once again, we observed private speech as the subjects worked on mathematics problems at their desks.

We compared these observations to the private speech of 19 normal boys matched in age and verbal ability.

Contrary to the assumptions underlying self-instructional training, ADHD boys did not use less private speech. Instead they made substantially more audible, self-guiding remarks than did normal boys. Furthermore, we examined age-related trends and found that the only difference between the two groups was that ADHD boys made the transition from audible speech to more internalized forms at a later age.

We uncovered a possible explanation for this developmental lag. Our results implied that ADHD children's severe attention deficit prevented their private speech from gaining efficient control over their behavior. First, only in the least distractible ADHD boys did audible self-guiding speech correlate with improved attention to math assignments. Second, we tracked a subsample of ADHD subjects while they were both taking and not taking stimulant drug medication, the most widely used treatment for the disorder. (Although stimulants do not cure ADHD, a large body of evidence indicates that they boost attention and academic performance in most children who take them.) We found that this medication sharply increased the maturity of private speech in ADHD boys. And only when these children were medicated did the most mature form of private speech, inaudible muttering, relate to improved self-control.

The promising nature of these findings encouraged me to include children having learning disabilities in the research. My colleague Steven Landau joined me in observing 112 third to sixth graders working on math and English exercises at their desks. Half of the children met the Illinois state guidelines for being classified as learning disabled: their academic achievement fell substantially below what would be expected based on their intelligence. The other half served as controls. As in the ADHD study, we found that the children who had learning disabilities used more au-

dible, self-guiding utterances and internalized their private speech at a later age than did children who did not have a disability. When we looked at a subgroup of learning disabled children who also displayed symptoms of ADHD, this trend was even more pronounced.

Research on children suffering from persistent learning difficulties vigorously supports Vygotsky's view of private speech. These children follow the same course of development as do their unaffected age mates, but impairments in their cognitive processing and ability to pay attention make academic tasks more difficult for them. This difficulty in turn complicates verbal self-regulation. Our findings suggest that training children who have learning and behavior problems to talk to themselves while performing cognitive tasks amounts to no more than invoking a skill they already possess. Furthermore, interventions that push children to move quickly toward silent self-communication may be counterproductive. While concentrating, ADHD and learning-disabled pupils show heightened dependence on audible private speech in an effort to compensate for their cognitive impairments.

How can our current knowledge of private speech guide us in teaching children who learn normally and those who have learning and behavior problems? The evidence as a whole indicates that private speech is a problem-solving tool universally available to children who grow up in rich, socially interactive environments. Several interdependent factors—the demands of a task, its social context and individual characteristics of a child—govern the extent and ease with which any one child uses self-directed speech to guide behavior. The most profitable intervention lies not in viewing private speech as a skill to be trained but rather in creating conditions that help children use private speech effectively.

When a child tries new tasks, he or she needs communicative support from an adult who is patient and encourag-

ing and who offers the correct amount of assistance given the child's current skills. For example, when a child does not understand what an activity entails, an adult might first give the child explicit directions. Once the child realizes how these actions relate to the task's goal, the adult might offer strategies instead. Gradually, adults can withdraw this support as children begin to guide their own initiatives.

Too often, inattentive and impulsive children are denied this scaffold for learning. Because of the stressful behaviors they bring to the adult-child relationship, they are frequently targets of commands, reprimands and criticism, all of which keep them from learning how to control their own actions.

Finally, parents and teachers need to be aware of the functional value of private speech. We now know that private speech is healthy, adaptive and essential behavior and that some children need to use it more often and for a longer period than others. Still, many adults continue to regard private speech as meaningless, socially unacceptable conduct—even as a sign of mental illness. As a result, they often discourage children from talking to themselves. At home, parents can listen to their child's private speech and thus gain insight into his or her plans, goals and difficulties. Likewise, teachers can be mindful of the fact that when pupils use more private speech than is typical for their age, they may need extra support and guidance. Certainly, we have much more to discover about how children solve problems using spontaneous private speech. Nevertheless, Vygotsky's theory has greatly deepened our understanding of this phenomenon. Today it is helping us design more effective teaching methods for all children and treatments for children suffering from learning and behavior problems. One can only regret that earlier generations of psychologists and educators—and those they might have helped—did not have the advantage of Vygotsky's insights.

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SCARS THAT WON'T HEAL:

originally published in March 2002

THE NEUROBIOLOGY OF CHILD ABUSE

*Maltreatment at an early age can have
enduring negative effects on
a child's brain development and function*

By Martin H. Teicher

In 1994 Boston police were shocked to discover a malnourished four-year-old locked away in a filthy Roxbury apartment, where he lived in dreadfully squalid conditions. Worse, the boy's tiny hands were found to have been horrendously burned. It emerged that his drug-abusing mother had held the child's hands under a steaming-hot faucet to punish him for eating her boyfriend's food, despite her instructions not to do so. The ailing youngster had been given no medical care at all. The disturbing story quickly made national headlines. Later placed in foster care, the boy received skin grafts to help his scarred hands regain their function. But even though the victim's physical wounds were treated, recent research findings indicate that any injuries inflicted to his developing mind may never truly heal.

Though an extreme example, the notorious case is unfortunately not all that uncommon. Every year child welfare agencies in the U.S. receive more than three million allegations of childhood abuse and neglect and collect sufficient

evidence to substantiate more than a million instances.

It is hardly surprising to us that research reveals a strong link between physical, sexual and emotional mistreatment of children and the development of psychiatric problems. But in the early 1990s mental health professionals believed that emotional and social difficulties occurred mainly through psychological means. Childhood maltreatment was understood either to foster the development of intrapsychic defense mechanisms that proved to be self-defeating in adulthood or to arrest psychosocial development, leaving a "wounded child" within. Researchers thought of the damage as basically a software problem amenable to reprogramming via therapy or simply erasable through the exhortation "Get over it."

New investigations into the consequences of early maltreatment, including work my colleagues and I have done at McLean Hospital in Belmont, Mass., and at Harvard Medical School, appear to tell a different story. Because childhood abuse occurs during the critical formative



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More than **THREE MILLION** allegations of childhood **ABUSE** and **NEGLECT** are received every year.

time when the brain is being physically sculpted by experience, the impact of severe stress can leave an indelible imprint on its structure and function. Such abuse, it seems, induces a cascade of molecular and neurobiological effects that irreversibly alter neural development.

Extreme Personalities

THE AFTERMATH of childhood abuse can manifest itself at any age in a variety of ways. Internally it can appear as depression, anxiety, suicidal thoughts or posttraumatic stress; it can also be expressed outwardly as aggression, impulsiveness, delinquency, hyperactivity or substance abuse. One of the more perplexing psychiatric conditions that is strongly associated with early ill-treatment is borderline personality disorder. Someone with this dysfunction characteristically sees others in black-and-white terms, often first putting a person on a pedestal, then vilifying the same person after some perceived slight or betrayal. Those afflicted are also prone to volcanic outbursts of anger and transient episodes of paranoia or psychosis. They typically have a history of intense, unstable relationships, feel empty or unsure of their identity, commonly try to escape through

substance abuse, and experience self-destructive or suicidal impulses.

While treating three patients with borderline personality disorder in 1984, I began to suspect that their early exposure to various forms of maltreatment had altered the development of their limbic systems. The limbic system is a collection of interconnected brain nuclei (neural centers) that play a pivotal role in the regulation of emotion and memory. Two critically important limbic regions are the hippocampus and the amygdala, which lie below the cortex in the temporal lobe [see *illustration on opposite page*]. The hippocampus is thought to be important in the formation and retrieval of both verbal and emotional memories, whereas the amygdala is concerned with creating the emotional content of memory—for example, feelings relating to fear conditioning and aggressive responses.

My McLean colleagues Yutaka Ito and Carol A. Glod and I wondered whether childhood abuse might disrupt the healthy maturation of these brain regions. Could early maltreatment stimulate the amygdala into a state of heightened electrical irritability or damage the developing hippocampus through excessive exposure to stress hormones? We reasoned further

that hippocampal harm or amygdaloid overexcitation could produce symptoms similar to those experienced by patients with temporal lobe epilepsy (TLE), which sporadically disrupts the function of these brain nuclei. During TLE seizures, patients remain conscious while experiencing a range of psychomotor symptoms brought on by electrical storms within these regions. Associated effects include the abrupt onset of tingling, numbness or vertigo; motor-related manifestations such as uncontrollable staring or twitching; and autonomic symptoms such as flushing, nausea or the “pit in your stomach” feeling one gets in a fast-rising elevator. TLE can also cause hallucinations or illusions in any of the five senses. It is not unusual, for instance, for one afflicted with this condition to experience Alice-in-Wonderland-like distortions of the sizes or shapes of objects. Disconnected feelings of déjà vu and mind-body dissociation are also common.

Abuse-Driven Brain Changes

TO EXPLORE the relation between early abuse and dysfunction of the limbic system, in 1984 I devised a checklist of questions that assess the frequency with which patients experience TLE-related symptoms. In 1993 my co-workers and I reported results from 253 adults who came to an outpatient mental health clinic for psychiatric evaluation. Slightly more than half reported having been abused physically or sexually, or both, as children. Compared with patients who reported no ill-treatment, average checklist scores were 38 percent greater in the patients with physical (but not sexual) abuse and 49 percent higher in the patients with sexual (but not other physical) mistreatment.

Overview/*Insight into Child Abuse*

- Until recently, psychologists believed that mistreatment during childhood led to arrested psychosocial development and self-defeating psychic defense mechanisms in adults. New brain imaging surveys and other experiments have shown that child abuse can cause permanent damage to the neural structure and function of the developing brain itself.
- This grim result suggests that much more effort must be made to prevent childhood abuse and neglect before it does irrevocable harm to millions of young victims. New approaches to therapy may also be indicated.

Patients who acknowledged both physical and sexual abuse had average scores 113 percent higher than patients reporting none. Maltreatment before age 18 had more impact than later abuse, and males and females were similarly affected.

In 1994 our McLean research team sought to ascertain whether childhood physical, sexual or psychological abuse was associated with brain-wave abnormalities in electroencephalograms (EEGs), which provide a more direct measure of limbic irritability than our checklist. We reviewed the records of 115 consecutive admissions to a child and adolescent psychiatric hospital to search for a link. We found clinically significant brain-wave abnormalities in 54 percent of patients with a history of early trauma but in only 27 percent of nonabused patients. We observed EEG anomalies in 72 percent of those who had documented histories of serious physical and sexual abuse. The irregularities arose in frontal and temporal brain regions and, to our surprise, specifically involved the left hemisphere rather than both sides, as one would expect.

Our findings dovetailed with a 1978 EEG study of adults who were victims of incest. The study's author, Robert W. Davies of the Yale University School of Medicine, and his team had found that 77 percent exhibited EEG abnormalities and 27 percent experienced seizures.

Subsequent work by other investigators using magnetic resonance imaging (MRI) technology has confirmed an association between early maltreatment and reductions in the size of the adult hippocampus. The amygdala may be smaller as well. In 1997 J. Douglas Bremner, then at the Yale University School of Medicine, and his colleagues compared MRI scans of 17 adult survivors of childhood physical or sexual abuse, all of whom had posttraumatic stress disorder (PTSD), with 17 healthy subjects matched for age, sex, race, handedness, years of education, and years of alcohol abuse. The left hippocampus of abused patients with PTSD was, on average, 12 percent smaller than the hippocampus of the healthy control subjects, but the right hippocampus was of normal size. Not surprisingly,

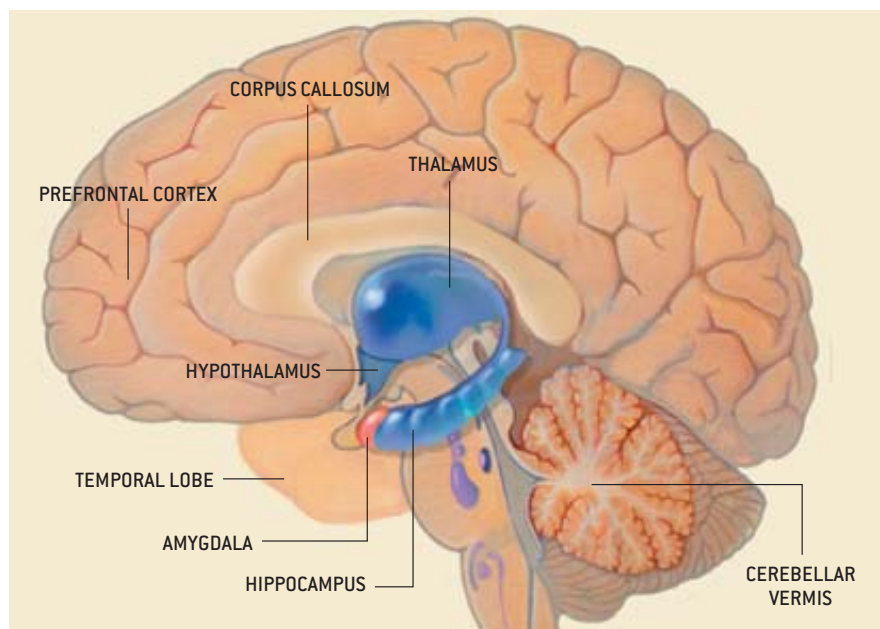
given the important role of the hippocampus in memory function, these patients also scored lower on verbal memory tests than the nonabused group.

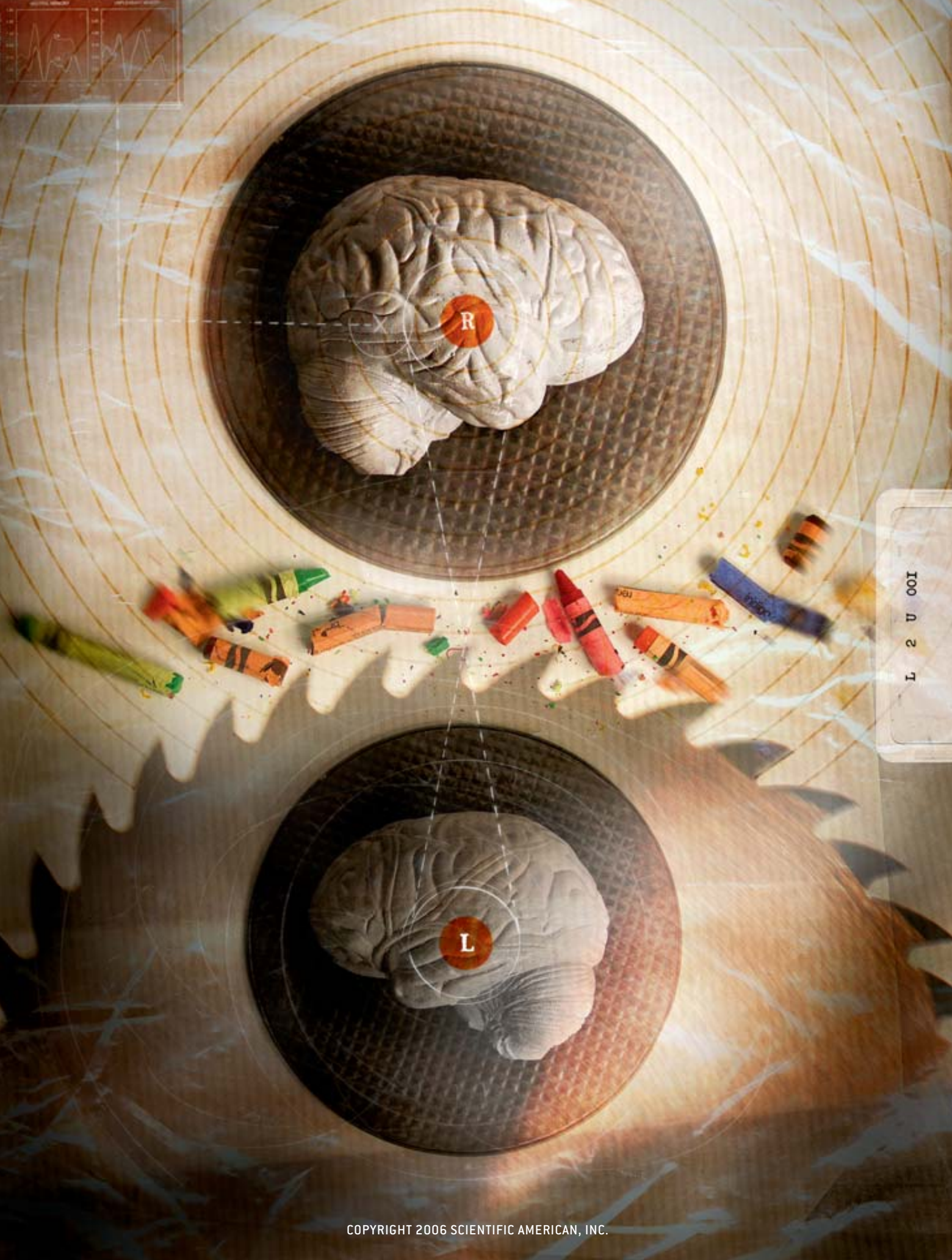
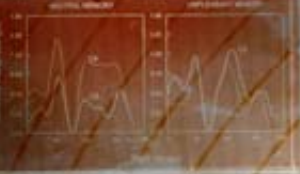
In 1997 Murray B. Stein of the University of California at San Diego also found left hippocampal abnormalities in 21 adult women who had been sexually abused as children and who had PTSD or dissociative identity disorder (also called multiple personality disorder, a condition thought by some researchers to be common in abused females). Stein determined that in these women the volume of the left hippocampus was significantly reduced but that the right hippocampus was relatively unaffected. In addition, he found a clear correspondence between the degree of reduction in hippocampus size and the severity of the patients' dissociative symptoms. In 2001 Martin Driessen of Gilead Hospital in Bielefeld, Germany, and his colleagues reported a 16 percent reduction in hippocampus size and an 8 percent reduction in amygdala size in adult women with borderline personality disorder and a history of childhood maltreatment.

On the other hand, when Michael D. De Bellis and his colleagues at the University of Pittsburgh School of Medicine carefully measured MRI images of the hippocampus in 44 maltreated children with PTSD and 61 healthy control subjects in 1999, they failed to observe a significant difference in volume.

My McLean colleagues Susan Andersen and Ann Polcari and I obtained similar results in our recently completed volumetric analysis of the hippocampus in 18 young adults (18 to 22 years of age) with a history of repeated forced sexual abuse accompanied by fear or terror, who were compared with 19 healthy age-matched controls. Unlike in previous studies, the control subjects were not patients but were recruited from the general public and had fewer mental health problems. We observed no differences in hippocampal volume. Like Driessen's group, however, we did find a 9.8 percent average reduction in the size of the left amygdala, which correlated with feelings of depression and irritability or hostility. We asked ourselves why the hippocampus was smaller in abused subjects in

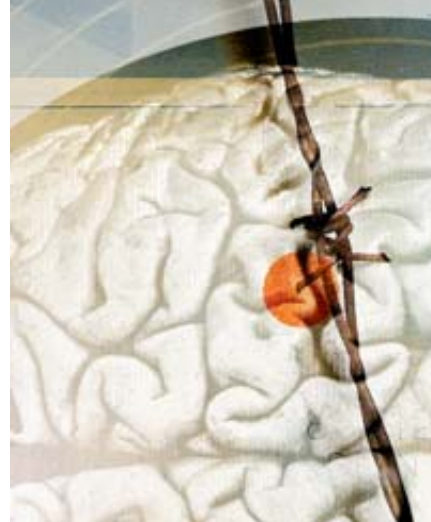
ANTISOCIAL BEHAVIOR resulting from childhood abuse appears to be caused by overexcitation of the limbic system, the primitive midbrain region that regulates memory and emotion. Two relatively small, deep-lying brain structures—the hippocampus and the amygdala—are thought to play prominent roles in generating this kind of interpersonal dysfunction. The hippocampus is important in determining what incoming information will be stored in long-term memory. The principal task of the amygdala is to filter and interpret incoming sensory information in the context of the individual's survival and emotional needs and then to help initiate appropriate responses.





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Researchers thought of the damage as a **SOFTWARE PROBLEM** amenable to reprogramming via therapy.



studies from Bremner's, Stein's and Dreissen's groups but normal in De Bellis's and in our own investigations. Of the several possible answers, the most likely is that stress exerts a very gradual influence on the hippocampus, so adverse effects may not be discernible at a gross anatomical level until people get older.

Moreover, animal studies by Bruce S. McEwen of the Rockefeller University and Robert M. Sapolsky of Stanford University had previously demonstrated the marked vulnerability of the hippocampus to the ravages of stress. Not only is the hippocampus particularly susceptible because it develops slowly, it also is one of the few brain regions that continues to grow new neurons after birth. Further, it has a higher density of receptors for the stress hormone cortisol than almost any other area of the brain. Exposure to stress hormones can significantly change the shape of the largest neurons in the hippocampus and can even kill them. Stress also suppresses production of the new granule cells (small neurons), which normally continue to develop after birth.

Experiments with rats by Christian Caldjí, Michael J. Meaney of McGill University and Paul M. Plotsky of Emory University have shown that early stress reconfigures the molecular organization of these regions. One major result is the alteration of the protein subunit structure of GABA receptors in the amygdala [see illustration on next page]. These receptors respond to gamma aminobutyric acid, the brain's primary inhibitory neurotransmitter, and GABA attenuates the electrical excitability of neurons. Reduced function of this neurotransmitter produces excessive electrical activity and can trigger seizures. This discovery pro-

vides an elegant molecular explanation for our findings of EEG abnormalities and limbic irritability in patients with childhood abuse.

Left-Side Problems

THE EFFECT on the limbic system was only the most expected consequence of childhood trauma. We were intrigued, however, by our earlier observation that ill-treatment was associated with EEG abnormalities in the left hemisphere. This inspired us to examine the effect of early abuse on the development of the left and right hemispheres. We chose to use EEG coherence, a sophisticated quantitative analysis method that provides evidence about the brain's microstructure—its wiring and circuitry. Conventional EEG, in contrast, reveals brain function. The EEG coherence technique accomplishes its task by generating a mathematical measure of the degree of cross-correlation among the elaborate neuronal interconnections in the cortex that process and modify the brain's electrical signals. In general, abnormally high levels of EEG coherence are evidence of diminished development among these neuron interchanges.

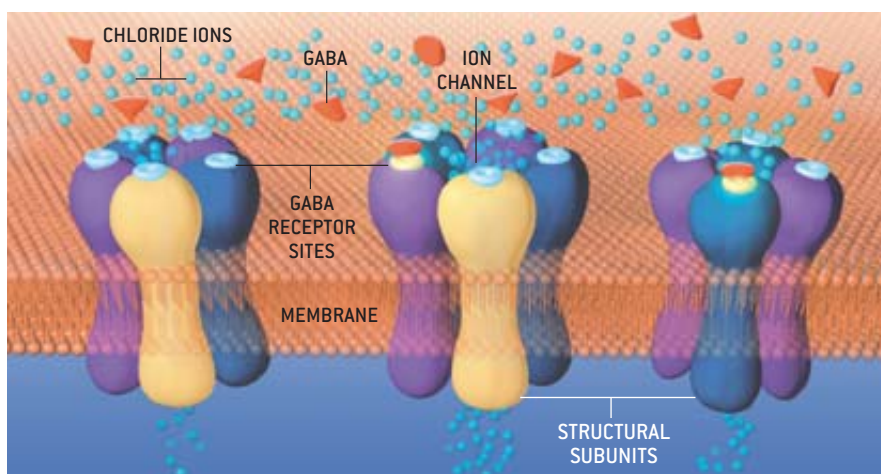
Our research team used this technique in 1997 to compare 15 healthy volunteers with 15 child and adolescent psychiatric patients who had a confirmed history of intense physical or sexual abuse. Coherence measures showed that the left cortices of the healthy control subjects were more developed than the right cortices, a result that is consistent with what is known about dominant hemisphere anatomy—that is, right-handed people tend to be left-cortex dominant. The maltreated patients, however, were notably more developed in the right cortex than the left,

even though all were right-handed and hence left-dominant. The right hemispheres of abused patients had developed as much as the right hemispheres of the control subjects, but their left hemispheres lagged substantially behind. This anomalous result showed up regardless of the patient's primary diagnosis. And although the effect extended throughout the entire left hemisphere, the temporal regions were most affected, which supported our original hypothesis.

The left hemisphere is specialized for perceiving and expressing language, whereas the right hemisphere specializes in processing spatial information and in processing and expressing emotions—particularly negative emotions. We had wondered whether mistreated children might store their disturbing memories in the right hemisphere and whether recollecting these memories might preferentially activate the right hemisphere.

To test this hypothesis, Fred Schiffer worked in my laboratory at McLean in 1995 to measure hemispheric activity in adults during recall of a neutral memory and then during recall of an upsetting early memory. Those with a history of abuse appeared to use predominantly their left hemispheres when thinking about neutral memories and their right when recalling an early disturbing memory. Subjects in the control group used both hemispheres to a comparable degree for either task, suggesting that their responses were more integrated between the two hemispheres.

Because Schiffer's research indicated that childhood trauma was associated with diminished right-left hemisphere integration, we decided to look for some deficiency in the primary pathway for infor-



FEWER INHIBITIONS: Stress causes changes to normal postsynaptic receptors (*left*) for gamma aminobutyric acid (GABA), the major inhibitory neurotransmitter in the central nervous system. It may lead to overstimulation of neurons, resulting in limbic system irritability. The presence of GABA lowers the electrical excitability of neurons by allowing greater flow of chloride ions (*center*). Loss of one of the GABA receptor's key structural subunits impairs its ability to moderate neural activity (*right*).

mation exchange between the two hemispheres, the corpus callosum. In 1997 Andersen and I collaborated with Jay Giedd of the National Institute of Mental Health to search for the posited effect. Together we found that in boys who had been abused or neglected, the middle parts of the corpus callosum were significantly smaller than in the control groups. Furthermore, in boys, neglect exerted a far greater effect than any other kind of maltreatment. In girls, however, sexual abuse was a more powerful factor, associated with a major reduction in size of the middle parts of the corpus callosum. These results were replicated and extended in 1999 by De Bellis. Likewise, the effects of early experience on the development of the corpus callosum have been confirmed by research in primates by Mara M. Sanchez of Emory.

Our latest finding had its roots in the seminal studies of Harry F. Harlow of the University of Wisconsin–Madison. In the 1950s Harlow compared monkeys

raised by their mothers with monkeys reared by wire or terrycloth surrogate mothers. Monkeys raised with the surrogates became socially deviant and highly aggressive adults. Working with Harlow, W. A. Mason of the Delta Primate Center in Louisiana discovered that these consequences were less severe if the surrogate mother was swung from side to side. J. W. Prescott of the National Institute of Child Health and Human Development hypothesized that this movement would be conveyed to the cerebellum, particularly the middle part, called the cerebellar vermis, located at the back of the brain just above the brain stem. Among other functions, the vermis modulates the brain-stem nuclei that control the production and release of the neurotransmitters norepinephrine and dopamine. Like the hippocampus, this part of the brain develops gradually and continues to create neurons after birth. It has an even higher density of receptors for stress hormones than the hippocampus, so exposure to such hormones can strongly affect its development.

Abnormalities in the cerebellar vermis have recently been reported to be associated with various psychiatric disorders, including manic-depressive illness, schizophrenia, autism and attention-deficit/hyperactivity disorder. These maladies emerge from genetic and prenatal

factors, not childhood mistreatment, but the fact that vermal anomalies seem to sit at the core of so many psychiatric conditions suggests that this region plays a critical role in mental health.

Dysregulation of the vermis-controlled neurotransmitters norepinephrine and dopamine can produce symptoms of depression, psychosis and hyperactivity as well as impair attention. Activation of the dopamine system has been associated with a shift to a more left hemisphere-biased (verbal) attentional state, whereas activation of the norepinephrine system shifts attention to a more right hemisphere-biased (emotional) state. Perhaps most curiously, the vermis also helps to regulate electrical activity in the limbic system, and vermal stimulation can suppress seizure activity in the hippocampus and amygdala.

R. G. Heath, working at Tulane University in the 1950s, found that Harlow's monkeys had seizure foci in their fastigial nuclei and hippocampus. In later work with humans, he found that electrical stimulation of the vermis reduced the frequency of seizures and improved the mental health in a small number of patients with intractable neuropsychiatric disorders. This result led my colleagues and me to speculate whether childhood abuse could produce abnormalities in the cerebellar vermis that contributed to psychiatric symptoms, limbic irritability and gradual hippocampal degeneration.

To begin to test this hypothesis, Carl M. Anderson recently worked in tandem with me and with Perry Renshaw at the Brain Imaging Center at McLean. Anderson used T2-relaxometry methods, a new MRI-based functional imaging technique we developed. For the first time, we can monitor regional cerebral blood flow at rest without the use of radioactive tracers or contrast dyes.

When the brain is resting, the neuronal activity of a region closely matches the amount of blood that area receives to sustain this activity. Anderson found a striking correlation between the activity in the cerebellar vermis and the degree of limbic irritability indicated by my TLE-related question checklist in both healthy young adult controls and young adults

STRESS sculpts the brain to exhibit various ANTISOCIAL, though adaptive, behaviors.



with a history of repeated sexual abuse.

At any level of limbic symptomatology, however, the amount of blood flow in the vermis was markedly decreased in the individuals with a history of trauma. Low blood flow points to a functional impairment in the activity of the cerebellar vermis. On average, abused patients had higher checklist scores presumably because their vermis could not activate sufficiently to quell higher levels of limbic irritability.

Together these findings suggest an intriguing model that explains one way in which borderline personality disorder can emerge. Reduced integration between the right and left hemispheres and a smaller corpus callosum may predispose these patients to shift abruptly from left- to right-dominated states with very different emotional perceptions and memories. Such polarized hemispheric dominance could cause a person to see friends, family and co-workers in an overly positive way in one state and in a resoundingly negative way in another—which is the hallmark of this disorder. Moreover, limbic electrical irritability can produce symptoms of aggression, exasperation and anxiety. Abnormal EEG activity in the temporal lobe is also often seen in people with a greatly increased risk for suicide and self-destructive behavior.

Adaptive Detriment

OUR TEAM INITIATED this research with the hypothesis that early stress was a toxic agent that interfered with the normal, smoothly orchestrated progression of brain development, leading to enduring psychiatric problems. Frank W. Putnam of Children's Hospital Medical Center of Cincinnati and Bruce D. Perry of the

Alberta Mental Health Board in Canada have now articulated the same hypothesis. I have come to question and reevaluate our starting premise, however. Human brains evolved to be molded by experience, and early difficulties were routine during our ancestral development. Is it plausible that the developing brain never evolved to cope with exposure to maltreatment and so is damaged in a nonadaptive manner? This seems most unlikely. The logical alternative is that exposure to early stress generates molecular and neurobiological effects that alter neural development in an adaptive way that prepares the adult brain to survive and reproduce in a dangerous world.

What traits or capacities might be beneficial for survival in the harsh conditions of earlier times? Some of the more obvious are the potential to mobilize an intense fight-or-flight response, to react aggressively to challenge without undue hesitation, to be at heightened alert for danger and to produce robust stress responses that facilitate recovery from injury. In this sense, we can reframe the brain changes we observed as adaptations to an adverse environment.

Although this adaptive state helps to take the affected individual safely through the reproductive years (and is even likely to enhance sexual promiscuity), which are critical for evolutionary success, it comes at a high price. McEwen has recently theorized that overactivation of stress re-

sponse systems, a reaction that may be necessary for short-term survival, increases the risk for obesity, type II diabetes and hypertension; leads to a host of psychiatric problems, including a heightened risk of suicide; and accelerates the aging and degeneration of brain structures, including the hippocampus.

We hypothesize that adequate nurturing and the absence of intense early stress permits our brains to develop in a manner that is less aggressive and more emotionally stable, social, empathic and hemispherically integrated. We believe that this process enhances the ability of social animals to build more complex interpersonal structures and enables humans to better realize their creative potential.

Society reaps what it sows in the way it nurtures its children. Stress sculpts the brain to exhibit various antisocial, though adaptive, behaviors. Whether it comes in the form of physical, emotional or sexual trauma or through exposure to warfare, famine or pestilence, stress can set off a ripple of hormonal changes that permanently wire a child's brain to cope with a malevolent world. Through this chain of events, violence and abuse pass from generation to generation as well as from one society to the next. Our stark conclusion is that we see the need to do much more to ensure that child abuse does not happen in the first place, because once these key brain alterations occur, there may be no going back. 

MORE TO EXPLORE

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McLean Hospital: www.mcleanhospital.org/

HOW SHOULD READING BE TAUGHT?

Educators have long argued over the best way to teach reading to children. The research, however, indicates that a highly popular method is inadequate on its own

By Keith Rayner, Barbara R. Foorman,
Charles A. Perfetti, David Pesetsky and
Mark S. Seidenberg

originally published in March 2002

Most of us are a little fuzzy on how we learned to read, much as we cannot recall anything special about learning to talk. Although these skills are related, the ways we acquire them differ profoundly. Learning to speak is automatic for almost all children brought up in normal circumstances, but learning to read requires elaborate instruction and conscious effort. Remember how hard it once was? Reading this page with the magazine turned upside down should bring back some of the struggles of early childhood, when working through even a simple passage was a slog.

Well aware of the difficulties, educators have given a great deal of thought to how they can best help children learn to read. No single method has triumphed. Indeed, heated arguments about the most appropriate form of reading instruction continue to polarize the teaching com-

munity. To help forge a consensus, we recently came together under the aegis of the American Psychological Society to review the voluminous research on the mental processing that underlies skilled reading and on how reading should be taught. The results point strongly in directions that may disturb some parents.

Three general approaches have been tried. In one, called whole-word instruction (also known as the “look-say” method), children learn by rote how to recognize at a glance a vocabulary of 50 to 100 words. Then they gradually acquire other words, often through seeing them used over and over in the context of a story. (“Run, Spot, run,” from the well-known Dick and Jane series of readers, is a classic example of a sentence designed to aid whole-word instruction.) This procedure could just as well be used to learn Chinese, in which each character in the written lan-

guage corresponds to a word or word root.

Actually, for the past half a century, youngsters in China have followed a different prescription: as a first step toward literacy, they are taught to read Chinese words using the Roman alphabet. Similarly, speakers of most other languages learn the relationship between letters and the sounds associated with them (phonemes). That is, children are taught how to use their knowledge of the alphabet to sound out words. This procedure constitutes a second approach to teaching reading—the phonics so familiar to baby boomers.

The connections between letters and phonemes would appear simple enough. For example, the letter “b” almost always sounds the same as it does in the word “bat.” Or consider the silent “e,” which denotes that the preceding vowel has a long sound, as in the words “pave,” “save” and “gave.” Although the final “e” is not voiced, its role is straightforward. English, however, offers plenty of exceptions—take the word “have.” There are, in fact, hundreds of deviations from the normal patterns, including “give,” “said,” “is,” “was,” “were,” “done” and “some.” Such problematic yet common words are among the first a child has to learn.

Clearly, the lack of perfect correspondence between letters and sounds is a source of confusion and a potential roadblock for the beginning reader. As a result, many schools have adopted a different approach: the whole-language method (also called literature-based instruction or guided reading). The strategy here is similar to whole-word instruction, but it relies more heavily on the child’s experience with language. For example, students are offered engaging books and are encouraged to guess the words that they do not know by considering the context of the sentence or by looking for clues in the story line and illustrations, rather than trying to sound them out. Often children are given the opportunity to write stories of their own, in an effort to instill a love of words and reading.

The whole-language approach aims to make reading in-

struction enjoyable. One of its key principles is that the rules of phonics should *not* be taught directly. Rather the connection between letters and sounds should be learned incidentally through exposure to text. This methodology stipulates that students should not be corrected when they make errors reading words. The philosophical rationale is that learning to read, like learning to speak, is a natural act that children can essentially teach themselves how to do. Just how well that assumption holds up in practice often depends on the individual.

How Beginners Learn to Read

ALTHOUGH MANY PARENTS might think that innate intelligence will govern how well their kids learn to read no matter what type of instruction is given, the evidence suggests otherwise. Two separate studies from the 1960s and 1970s have shown that, in general, IQ has very little bearing on early reading ability. More recently, researchers have found that children who have difficulty learning to read often have above-average IQs.

It might also be tempting to believe that the differences in early reading ability wash out over time, but that, too, is a misconception. Keith E. Stanovich of the University of Toronto has, for example, shown that children’s facility with reading in the first grade usually provides a good indication of what their 11th-grade reading proficiency will turn out to be. Why? Because reading requires practice, and those who excel end up practicing the most. Hence, the gap between more and less able readers in the first few grades generally grows over the years.

Teaching children to read well early on obviously helps to develop a valuable lifetime habit; thus, it is no wonder that educators have placed enormous emphasis on finding the best way to teach these skills. At one time, a great deal of debate in educational circles centered on whether whole-word or phonics instruction was the most effective. But over the past decade or so, arguments have revolved around the relative merits of phonics and whole-word’s successor, whole-language.

Many teachers adopted the whole-language approach because of its intuitive appeal. After all, making reading fun promises to keep children motivated, and learning to read depends more on what the student does than on what the teacher does. But the prospect of keeping kids interested would not have been enough by itself to convince teachers to use the whole-language method. What really sold it was an educational philosophy that empowered teachers to compose their own curricula and encouraged them to treat children as active participants, an enticing combination that was promoted with flair by some educator celebrities. The presumed benefits of whole-language instruction—and the stark contrast to the perceived dullness of phonics—led to its growing acceptance across America during the 1990s.

In Massachusetts, for example, whole-language almost became the official state method of instruction with passage of the Massachusetts Education Reform Act of 1993. That legislation changed what had been a tradition of little state involvement in school curriculum. The law promised to increase state funding for public education, and in exchange local school systems

Overview/Teaching Reading

- Learning to read is a crucial step in children’s education because those who fare poorly in the early grades are unlikely to catch up with their more skilled classmates, even after years of further schooling.
- During the 1990s many educators in America abandoned the traditional “phonics” method of reading instruction: teaching children directly the correspondences between spoken sounds and letters that represent them. Instead elementary school teachers turned to various “whole-language” methods, by which students learn the connections between letters and sounds incidentally in the course of literature-based activities.
- Evaluations of the effectiveness of the two methods have shown that children become skilled readers much more readily when their instruction includes phonics. Modern research in psychology and linguistics helps to explain why this is so.

U.S. Government Studies Supporting Phonics Instruction

TITLE	ORGANIZER	SCOPE	SUMMARY STATEMENT
<i>Preventing Reading Difficulties in Young Children</i>	National Academy of Sciences/National Research Council (sponsored by the Department of Education); 1998	Literature review covering more than 700 publications	"Failure to grasp that written spellings systematically represent the sounds of spoken words makes it difficult not only to recognize printed words but also to understand how to learn and to profit from instruction. If a child cannot rely on the alphabetic principle, word recognition is inaccurate or laborious and comprehension of connected text will be impeded."
<i>Teaching Children to Read: An Evidence-Based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction</i>	National Reading Panel (convened by the National Institute of Child Health and Human Development, in consultation with the secretary of education); 2000	Includes a meta-analysis of 38 controlled studies of phonics instruction published since 1970	"The meta-analysis indicated that systematic phonics instruction enhances children's success in learning to read and that systematic phonics instruction is significantly more effective than instruction that teaches little or no phonics."

were required to meet new state standards.

Despite the previous lack of central control, the reading curricula in Massachusetts public schools were rather uniform—and it is not difficult to understand why. As in other places, teachers and administrators took the same courses at the same handful of universities, attended the same workshops, bought the same textbooks and responded to the same educational fashions. Hence, the committee of educators charged by the state government with framing a statement about how reading should be taught were heavily influenced by the whole-language approach. And naturally enough, the document they produced highlighted the idea that children could learn to read the same way they learned to talk. It presented a vision of language acquisition that attributed the process to curiosity and enthusiasm alone, and it seemed authoritative, claiming support from

research.

As it happens, Massachusetts is home to hubs of research in linguistics and the psychology of reading—at the Massachusetts Institute of Technology and the University of Massachusetts at Amherst. After the content of the proposed curriculum document became known, a number of scholars in these places (including two of us) reacted strongly. Dozens of linguists and psychologists signed a letter taking issue with the document's assertion that research supported whole-language instruction. They sent it to the state commissioner of education, who eventually saw to it that corrections were made and that state standards reflected the actual research results.

By chance, this incident took place just as debate about how to teach reading was heating up in other states (most notably, in California and Texas). Sides were often divided along political lines, with conservatives backing phonics and liberals favoring whole-language instruction. Consequently, the Massachusetts dispute drew national attention. In particular, conservative newsletters and Web sites created considerable publicity for the researchers' letter—an ironic twist, given that the list of professors who signed it included several well-known leftists.

THE AUTHORS

KEITH RAYNER, BARBARA R. FOORMAN, CHARLES A. PERFETTI, DAVID PESETSKY and MARK S. SEIDENBERG collaborated on a paper surveying the teaching of reading for the November 2001 issue of *Psychological Science in the Public Interest* [see "More to Explore," on page 25]. Rayner, Distinguished Professor of Psychology at the University of Massachusetts at Amherst, is currently on sabbatical in England at the University of Durham. Foorman is a professor of pediatrics at the University of Texas–Houston Health Science Center, where she directs the Center for Academic and Reading Skills. Perfetti is University Professor of Psychology and Linguistics at the University of Pittsburgh, where he is associate director of the Learning Research and Development Center. Pesetsky is Ferrari P. Ward Professor of Linguistics at the Massachusetts Institute of Technology. Seidenberg is a professor of psychology at the University of Wisconsin–Madison.

Why Phonics?

WHY DID SO MANY LINGUISTS and psychologists object strongly to the abandonment of phonics? In short, because research had clearly demonstrated that understanding how letters relate to the component sounds of words is critically important in reading. Our recent review of the topic shows that there is no doubt about it: teaching that makes the rules of phonics clear will ultimately be more successful than teaching that does not. Admittedly, some children can infer these principles on their

own, but most need explicit instruction in phonics, or their reading skills will suffer.

This conclusion rests, in part, on knowledge of how experienced readers make sense of words on a page—an understanding that psychologists have developed over many decades. One of the first researchers to investigate the nature of reading was James M. Cattell, an American psychologist of the Victorian era. To test whether proficient readers were taking in words letter by letter or all at once, he performed a pioneering experiment, exposing subjects very briefly to whole words or to individual letters and asking them what they saw. He found that they were better able to report words than letters. Thus, it seemed apparent to him that people do not absorb printed words one letter at a time. (Such findings helped to motivate the creation of the whole-word method later on.) More recent research has refined our knowledge of this phenomenon. For example, studies that track eye movements during reading show that although people register each letter in a word as a separate symbol, they normally perceive all the letters in a word simultaneously.

The question of whether accomplished readers mentally sound out words took longer to answer. Advocates of whole-

language instruction have argued forcefully for more than 20 years that people often derive meanings directly from print without ever determining the sound of the word. Some psychologists today accept this view, but most believe that reading is typically a process of rapidly sounding out words mentally, even for the highly skilled.

The most compelling evidence for this last contention comes from clever experiments by Guy Van Orden of Arizona State University wherein a subject is first asked a question, such as “Is it a flower?” He or she is then presented with a target word (for example, “rose”) and asked whether the word fits the category. Sometimes the subject is offered a word that sounds the same as a correct answer (called a homophone—say, “rows” instead of “rose”). Subjects often mistakenly identify such words as fitting the category, and these incorrect responses show that readers routinely convert strings of letters to sounds (or rather, to their unvoiced mental equivalents), which they then use to ascertain meanings.

Some eye-movement studies have used homophones to demonstrate that the process of sounding out words mentally begins very rapidly after a reader’s gaze first fixes on a particular

How Phonics Is Taught

IN TEACHING PHONICS, instructors present the spellings for different sounds in a specific order, introducing the simplest (or most useful) patterns early on. They then practice these patterns with their students using engaging stories. Shown below are 20 of the 120 or so patterns presented to first graders in one modern phonics program, *Open Court Reading*, from SRA/McGraw-Hill. Choosing another published system of phonics instruction would provide the students with a somewhat different scope and sequence, but the general strategy would be the same.

Some teachers prefer to dispense with such structured programs and to create phonics lessons on their own. Doing so is no small chore, because they have so many decisions to make. Should rules be taught for all the ways to spell

each of the approximately 40 distinct sounds (phonemes) of American English? For the long “a” alone, there are eight spelling patterns, as in “make,” “rain,” “say,” “they,” “baby,” “eight,” “vein” and “great.” And do all the phonemes need attention? For example, do the vowel sounds in “book” and “moon” both need to be taught?

Although some teachers can tackle these questions and create phonics lessons that are every bit as effective as those provided in a published program, most probably have too many demands on their time to take on that task. Just how much latitude phonics instructors should be given and how effectively they can make use of the flexibility remain points of debate in a number of school districts.

—K.R., B.R.F., C.A.P., D.P. and M.S.S.

Letter Pattern to Be Mastered (first 10 patterns taught)	One of the Words Used as Examples	Letter Pattern to Be Mastered (final 10 patterns taught)	One of the Words Used as Examples
m	monkey	ture	nature
a	lamb	ear	earn
t	time	or	worm
h	hound	ar	carry
p	popcorn	er	berry
n	nose	tion	nation
c	camera	ion	million
d	dinosaur	re	reheat
[contractions]	can't	ure	measure
s	sausages	ous	dangerous

word. And recent brain studies show that the primary motor cortex is active during reading, presumably because it is involved with mouth movements used in reading aloud.

Consequently, psychologists now know that the process of mentally sounding out words is an integral part of silent reading, even for the highly skilled. This understanding suggests that learning the correspondences between letters and sounds—that is to say, phonics—is keenly important for beginners. Further support for phonics instruction comes from experiments designed to mimic the way people learn to read.

Investigators have, for example, trained English-speaking college students to read using unfamiliar symbols such as Arabic letters. One group learned the phonemes associated with individual Arabic letters (the phonics approach), while another group learned entire words associated with certain strings of Arabic letters (whole-word). Then both groups were required to read a new set of words constructed from the original characters. In general, readers who were taught the rules of phonics could read many more new words than those trained with a whole-word procedure. Research using computer programs that simulate how children read also indicates that gaining a command of phonics is easier than learning to associate whole words with their meanings.

Classroom studies comparing phonics with either whole-word or whole-language instruction are also quite illuminating. The late Jeanne S. Chall of Harvard University carried out a comprehensive review of such work, as subsequently did Marilyn J. Adams, who was also affiliated with Harvard. In a nutshell, their reviews, as well as our own, show that systematic phonics instruction produces higher achievement for beginning readers. The differences are greatest for students at risk of failing to learn to read, such as those living in homes where the value of literacy is not emphasized.

One particularly persuasive study was undertaken as long ago as 1985. Mary Ann Evans of the University of Guelph in Canada and Thomas H. Carr of Michigan State University compared two programs used in 20 first-grade classrooms. Half the students were offered traditional reading instruction, which included the use of specially designed readers, phonics drills and applications. The other half were taught using an individualized method that drew from their experiences with language; these children produced their own booklets of stories and developed sets of words to be recognized (common components of the whole-language approach). The two groups spent the same amount of time on reading, had similar socioeconomic profiles and were virtually identical on measures of intelligence and language maturity. Yet this study found that the first group scored higher at year's end on tests of reading and comprehension.

More recent investigations (namely, authoritative evaluations by the National Reading Panel and the National Research Council) examining all the available studies echo these results. Influenced by such findings, the Bush administration is now promoting the inclusion of phonics in reading programs nationwide.

A Delicate Balance

IF RESEARCHERS ARE SO CONVINCED about the need for phonics instruction, why does the debate continue? Because the controversy is enmeshed in the philosophical differences between traditional and progressive approaches, differences that have divided American educators for years. The progressives challenge the results of laboratory tests and classroom studies on the basis of a broad philosophical skepticism about the value of such research. They champion student-centered learning and teacher empowerment. Sadly, they fail to realize that these very admirable educational values are equally consistent with the teaching of phonics.

If schools of education insisted that would-be reading teachers learned something about the vast research in linguistics and psychology that bears on reading, and if these institutions regularly included a modern, high-quality course on phonics, their graduates would be more eager to use phonics and would be prepared to do so effectively. They would not have to follow scripted programs or rely on formulaic workbooks and could allow their pupils to apply the principles of phonics while reading for pleasure. Using whole-language activities to supplement phonics instruction certainly helps to make reading fun and meaningful for children, so no one would want to see such tools discarded. Indeed, recent work has indicated—and many teachers have discovered—that the combination of literature-based instruction and phonics is more powerful than either method used alone.

Teachers obviously need to strike a balance. But in doing so, we urge them to remember that reading must be grounded in a firm understanding of the connections between letters and sounds. Instructors should recognize the ample evidence that youngsters who are directly taught phonics become better at reading, spelling and comprehension than those who must pick up all the confusing rules of English on their own. Educators who deny this reality are neglecting decades of research. They are also neglecting the needs of their students. SA

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UNCOMMON TALENTS:

Gifted Children, Prodigies and Savants

*Possessing abilities well beyond their years,
gifted children inspire admiration, but they also
suffer ridicule, neglect and misunderstanding*

by Ellen Winner

originally published in 1998

One evening a few years ago, while I was attending a concert, a young boy in the audience caught my attention. As the orchestra played a Mozart concerto, this nine-year-old child sat with a thick, well-thumbed orchestral score opened on his lap. As he read, he hummed the music out loud, in perfect tune. During intermission, I cornered the boy's father. Yes, he told me, Stephen was really reading the music, not just looking at it. And reading musical scores was one of his preferred activities, vying only with reading college-level computer programming manuals. At an age when most children concentrate on fourth-grade arithmetic and the nuances of playground etiquette, Stephen had already earned a prize in music theory that is coveted by adults.

Gifted children like Stephen are fascinating but also intimidating. They have been feared as "possessed," they have been derided as oddballs, they have been ridiculed as nerds. The parents of such young people are often criticized for pushing their children rather than allowing them a normal, well-balanced childhood. These children are so different from others that schools usually do not know how to educate them. Meanwhile society expects gifted children to become creative intellectuals and artists as adults and views them as failures if they do not.

Psychologists have always been interested in those who deviate from the norm, but just as they know more about psy-

chopathology than about leadership and courage, researchers also know far more about retardation than about giftedness. Yet an understanding of the most talented minds will provide both the key to educating gifted children and a precious glimpse of how the human brain works.

The Nature of Giftedness

Everyone knows children who are smart, hard-working achievers—youngsters in the top 10 to 15 percent of all students. But only the top 2 to 5 percent of children are gifted. Gifted children (or child prodigies, who are just extreme versions of gifted children) differ from bright children in at least three ways:

- Gifted children are precocious. They master subjects earlier and learn more quickly than average children do.
- Gifted children march to their own drummer. They make discoveries on their own and can often intuit the solution to a problem without going through a series of logical, linear steps.
- Gifted children are driven by "a rage to master." They have a powerful interest in the area, or domain, in which they have high ability—mathematics, say, or art—and they can readily focus so intently on work in this domain that they lose

sense of the outside world.

These are children who seem to teach themselves to read as toddlers, who breeze through college mathematics in middle school or who draw more skillfully as second-graders than most adults do. Their fortunate combination of obsessive interest and an ability to learn easily can lead to high achievement in their chosen domain. But gifted children are more susceptible to interfering social and emotional factors than once was thought.

The first comprehensive study of the gifted, carried out over a period of more than 70 years, was initiated at Stanford University in the early part of this century by Lewis M. Terman, a psychologist with a rather rosy opinion of gifted children. His study tracked more than 1,500 high-IQ children over the course of their lives. To qualify for the study, the “Termites” were first nominated by their teachers and then had to score 135 or higher on the Stanford-Binet IQ test (the average score is 100). These children were precocious: they typically spoke early, walked early and read before they entered school. Their parents described them as being insatiably curious and as having superb memories.

Terman described his subjects glowingly, not only as superior in intelligence to other children but also as superior in health, social adjustment and moral attitude. This conclusion easily gave rise to the myth that gifted children are happy and well adjusted by nature, requiring little in the way of special attention—a myth that still guides the way these children are educated today.

In retrospect, Terman’s study was probably flawed. No child entered the study unless nominated by a teacher as one of the best and the brightest; teachers probably overlooked those gifted children who were misfits, loners or problematic to teach. And the shining evaluations of social adjustment and personality in the gifted were performed by the same admiring teachers who had singled out the study subjects. Finally, almost a third of the sample came from professional, middle-class families. Thus, Terman confounded IQ with social class.

The myth of the well-adjusted, easy-to-teach gifted child persists despite more recent evidence to the contrary. Mihaly Csikszentmihalyi of the University of Chicago has shown that children with exceptionally high abilities in any area—not just in academics but in the visual arts, music, even athletics—are out of step with their peers socially. These children tend to be highly driven, independent in their thinking and introverted. They spend more than the usual amount of time alone, and although they derive energy and pleasure from their solitary mental lives, they also report feeling lonely. The more extreme the level of gift, the more isolated these children feel.

Contemporary researchers have estimated that about 20 to 25 percent of profoundly gifted children have social and emotional problems, which is about twice the normal rate; in contrast, moderately gifted children do not exhibit a higher than average rate. By middle childhood, gifted children often try to hide their abilities in the hopes of becoming more popular. One group particularly at risk for such underachievement is academically gifted girls, who report more depression, lower self-esteem and more psychosomatic symptoms than academically gifted boys do.

The combination of precocious knowledge, social isolation and sheer boredom in many gifted children is a tough challenge for teachers who must educate them alongside their peers. Worse, certain gifted children can leap years ahead of their peers in one area yet fall behind in another. These chil-

dren, the unevenly gifted, sometimes seem hopelessly out of sync.

The Unevenly Gifted

Terman was a proponent of the view that gifted children are globally gifted—evenly talented in all academic areas. Indeed, some special children have exceptional verbal skills as well as strong spatial, numerical and logical skills that enable them to excel in mathematics. The occasional child who completes college as an early teen—or even as a preteen—is likely to be globally gifted. Such children are easy to spot: they are all-around high achievers. But many children exhibit gifts in one area of study and are unremarkable or even learning disabled in others. These may be creative children who are difficult in school and who are not immediately recognized as gifted.

Unevenness in gifted children is quite common. A recent survey of more than 1,000 highly academically gifted adolescents revealed that more than 95 percent show a strong disparity between mathematical and verbal interests. Extraordinarily strong mathematical and spatial abilities often accompany average or even deficient verbal abilities. Julian Stanley of Johns Hopkins University has found that many gifted children selected for special summer programs in advanced math have enormous discrepancies between their math and verbal skills. One such eight-year-old scored 760 out of a perfect score of 800 on the math part of the Scholastic Assessment Test (SAT) but only 290 out of 800 on the verbal part.

In a retrospective analysis of 20 world-class mathematicians, psychologist Benjamin S. Bloom, then at the University of Chicago, reported that none of his subjects had learned to read before attending school (yet most academically gifted children do read before school) and that six had had trouble learning to read. And a retrospective study of inventors (who presumably exhibit high mechanical and spatial aptitude) showed that as children these individuals struggled with reading and writing.

Indeed, many children who struggle with language may have strong spatial skills. Thomas Sowell of Stanford University, an economist by training, conducted a study of late-talking children after he raised a son who did not begin to speak until almost age four. These children tended to have high spatial abilities—they excelled at puzzles, for instance—and most had relatives working in professions that require strong spatial skills. Perhaps the most striking finding was that 60 percent of these children had engineers as first- or second-degree relatives.

The association between verbal deficits and spatial gifts seems particularly strong among visual artists. Beth Casey of Boston College and I have found that college art students make significantly more spelling errors than college students major-



TYPICAL DRAWING by a five-year-old of average ability lacks detail and is highly schematic.

COURTESY OF ELLEN WINNER

WOLFGANG AMADEUS MOZART is among the best-known child prodigies. He began picking out tunes on the piano at three years of age; by four he could tell if a violin was a quarter tone out of tune, and by eight he could play without hesitation a complex piece he had never seen before. Mozart began composing at the age of five, when he wrote two minuets for the harpsichord. Even as a young child, he could play pieces perfectly from memory, having heard them only once, and improvise on a theme without ever repeating himself.

THOMAS ALVA EDISON exemplifies the unevenly gifted individual. Edison was a prolific inventor, obtaining 1,093 patents for innovations ranging from the phonograph to the incandescent light. As a child, he was obsessed with science and spent much time tinkering in a chemistry laboratory in his parents' cellar. Edison had some difficulties learning, though, especially in the verbal areas; he may have had symptoms of dyslexia. The coexistence of strong spatial-logical skills with a weakness in language is common in the unevenly gifted.

CALENDRIAL CALCULATORS GEORGE AND CHARLES, identical twins, are the most famous of such savants. Each could instantly compute the day of the week on which any given date, past or future, would fall. The twins were born in 1939 three months premature and retarded; their IQs tested between 40 and 70. Such an extraordinary ability to calculate in an otherwise extremely mentally disabled child mirrors the milder unevenness of gifts seen in children highly talented in mathematics but learning disabled in language.

WHEN BRILLIANCE ISN'T ENOUGH: William James Sidis [1898–1944] was profoundly gifted as a child, reading and spelling at the age of two, inventing a new table of logarithms at eight, speaking six languages by 10. By age 11 he was enrolled at Harvard University, delivering lectures on mathematics to the faculty. But Sidis's father had driven him mercilessly as a child, denying him any youthful pleasures and letting the media hound him. He grew deeply bitter and resentful of his father and lost all interest in mathematics after graduating from Harvard at 16. This talented young man spent the rest of his life in mindless clerical jobs, and his interests became obsessive and autisticlike: at 28 he wrote a comprehensive book on the classification of streetcar transfer slips. He died, alone, from a brain hemorrhage at 46.

ing either in math or in verbal areas such as English or history. On average, the art students not only misspelled more than half of a 20-word list but also made the kind of errors associated with poor reading skills—nonphonetic spellings such as “physicain” for “physician” (instead of the phonetic “fisician”).

The many children who possess a gift in one area and are weak or learning disabled in others present a conundrum. If schools educate them as globally gifted, these students will continually encounter frustration in their weak areas; if they are held back because of their deficiencies, they will be bored and unhappy in their strong fields. Worst, the gifts that these children do possess may go unnoticed entirely when frustrated, unevenly gifted children wind up as misfits or troublemakers.

Savants: Uneven in the Extreme

The most extreme cases of spatial or mathematical gifts coexisting with verbal deficits are found in savants. Savants are retarded (with IQs between 40 and 70) and are either autistic or show autistic symptoms. “Ordinary” savants usually possess one skill at a normal level, in contrast to their otherwise severely limited abilities. But the rarer savants—fewer than 100 are known—display one or more skills equal to prodigy level.

Savants typically excel in visual art, music or lightning-fast calculation. In their domain of expertise, they resemble child prodigies, exhibiting precocious skills, independent learning and a rage to master. For instance, the drawing savant named Nadia sketched more realistically at ages three and four than any known child prodigy of the same age. In addition, savants will often surpass gifted children in the accuracy of their memories.

Savants are like extreme versions of unevenly gifted children. Just as gifted children often have mathematical or artistic genius and language-based learning disabilities, savants tend to exhibit a highly developed visual-spatial ability alongside severe deficits in language. One of the most promising biological explanations for this syndrome posits atypical brain organization, with deficits in the left hemisphere of the brain (which usually controls language) offset by strengths in the right hemisphere (which controls spatial and visual skills).

According to Darold A. Treffert, a psychiatrist now in private practice in Fond du Lac, Wis., the fact that many savants were premature babies fits well with this notion of left-side brain damage and resultant right-side compensation. Late in pregnancy, the fetal brain undergoes a process called pruning, in which a large number of excess neurons die off [see “The Developing Brain,” by Carla J. Shatz; *SCIENTIFIC AMERICAN*, September 1992]. But the brains of babies born prematurely may not have been pruned yet; if such brains experience trauma to the left hemisphere near the time of birth, numerous uncommitted neurons elsewhere in the brain might remain to compensate for the loss, perhaps leading to a strong right-hemisphere ability.

Such trauma to a premature infant's brain could arise many ways—from conditions during pregnancy, from lack of oxygen during birth, from the administration of too much oxygen afterward. An excess of oxygen given to premature babies can cause blindness in addition to brain damage; many musical savants exhibit the triad of premature birth, blindness and strong right-hemisphere skill.

Gifted children most likely possess atypical brain organi-

zation to some extent as well. When average students are tested to see which part of their brain controls their verbal skills, the answer is generally the left hemisphere only. But when mathematically talented children are tested the same way, both the left and right hemispheres are implicated in controlling language—the right side of their brains participates in tasks ordinarily reserved for the left. These children also tend not to be strongly right-handed, an indication that their left hemisphere is not clearly dominant.

The late neurologist Norman Geschwind of Harvard Medical School was intrigued by the fact that individuals with pronounced right-hemisphere gifts (that is, in math, music, art) are disproportionately nonright-handed (left-handed or ambidextrous) and have higher than average rates of left-hemisphere deficits such as delayed onset of speech, stuttering or dyslexia. Geschwind and his colleague Albert Galaburda theorized that this association of gift with disorder, which they called the “pathology of superiority,” results from the effect of the hormone testosterone on the developing fetal brain.

Geschwind and Galaburda noted that elevated testosterone can delay development of the left hemisphere of the fetal brain; this in turn might result in compensatory right-hemisphere growth. Such “testosterone poisoning” might also account for the larger number of males than females who exhibit mathematical and spatial gifts, nonright-handedness and pathologies of language. The researchers also noted that gifted children tend to suffer more than the usual frequency of immune disorders such as allergies and asthma; excess testosterone can interfere with the development of the thymus gland, which plays a role in the development of the immune system.

Testosterone exposure remains a controversial explanation for uneven gifts, and to date only scant evidence from the study of brain tissue exists to support the theory of damage and compensation in savants. Nevertheless, it seems certain that gifts are hardwired in the infant brain, as savants and gifted children exhibit extremely high abilities from a very young age—before they have spent much time working at their gift.

Emphasizing Gifts

Given that many profoundly gifted children are unevenly talented, socially isolated and bored with school, what is the best way to educate them? Most gifted programs today tend to target children who have tested above 130 or so on standard IQ tests, pulling them out of their regular classes for a few hours each week of general instruction or interaction. Unfortunately, these programs fail the most talented students.

Generally, schools are focusing what few resources they have for gifted education on the moderately academically gifted. These children make up the bulk of current “pull-out” programs: bright students with strong but not extraordinary abilities, who do not face the challenges of precocity and isolation to the same degree as the profoundly gifted. These children—and indeed most children—would be better served if schools instead raised their standards across the board.

Other nations, including Japan and Hungary, set much higher academic expectations for their children than the U.S. does; their children, gifted or not, rise to the challenge by succeeding at higher levels. The needs of moderately gifted children could be met by simply teaching them a more demanding standard curriculum.

The use of IQ as a filter for gifted programs also tends to

tip these programs toward the relatively abundant, moderately academically gifted while sometimes overlooking profoundly but unevenly gifted children. Many of those children do poorly on IQ tests, because their talent lies in either math or language, but not both. Students whose talent is musical, artistic or athletic are regularly left out as well. It makes more sense to identify the gifted by examining past achievement in specific areas rather than relying on plain-vanilla IQ tests.

Schools should then place profoundly gifted children in advanced courses in their strong areas only. Subjects in which a student is not exceptional can continue to be taught to the student in the regular classroom. Options for advanced classes include arranging courses especially for the gifted, placing gifted students alongside older students within their schools, registering them in college courses or enrolling them in accelerated summer programs that teach a year’s worth of material in a few weeks.

Profoundly gifted children crave challenging work in their domain of expertise and the companionship of individuals with similar skills. Given the proper stimulation and opportunity, the extraordinary minds of these children will flourish. SA

About the Author

ELLEN WINNER was a student of literature and painting before she decided to explore developmental psychology. Her inspiration was Harvard University’s Project Zero, which researched the psychological aspects of the arts. Her graduate studies allowed her to combine her interests in art and writing with an exploration of the mind. She received her Ph.D. in psychology from Harvard in 1978 and is currently professor of psychology at Boston College as well as senior research associate with Project Zero.

One of Winner’s greatest pleasures is writing books; she has authored three, one on the psychology of the arts, another on children’s use of metaphor and irony and, most recently, *Gifted Children: Myths and Realities*. “I usually have several quite different projects going at once, so I am always juggling,” she remarks. She is especially intrigued by unusual children—children who are gifted, learning disabled, gifted and learning disabled, nonright-handed or particularly creative. “The goal is to understand cognitive development in its typical and atypical forms.”

When she has time to play, Winner devours novels and movies and chauffeurs her 13-year-old son on snowboarding dates. She is married to the psychologist Howard Gardner and has three grown stepchildren.



[illegible]

MARCH 2006

begun to clarify its symptoms and causes and have found that it may have a genetic underpinning. Today's view of the basis of the condition is strikingly different from that of just a few years ago. We are finding that ADHD is not a disorder of attention per se, as had long been assumed. Rather it arises as a developmental failure in the brain circuitry that underlies inhibition and self-control. This loss of self-control in turn impairs other important brain functions crucial for maintaining attention, including the ability to defer immediate rewards for later, greater gain.

ADHD involves two sets of symptoms: inattention and a combination of hyperactive and impulsive behaviors [see *table on next page*]. Most children are more active, distractible and impulsive than adults. And they are more inconsistent, affected by momentary events and dominated by objects in their immediate environment. The younger the children, the less able they are to be aware of time or to give priority to future events over more immediate wants. Such behaviors are signs of a problem, however, when children display them significantly more than their peers do.

Boys are at least three times as likely as girls to develop the disorder; indeed, some studies have found that boys with ADHD outnumber girls with the condition by nine to one, possibly because boys are genetically more prone to disorders of the nervous system. The behavior patterns that typify ADHD usually arise between the ages of three and five. Even so, the age of onset can vary widely: some children do not develop symptoms until late childhood or even early adolescence. Why their symptoms are delayed remains unclear.

Huge numbers of people are affected. Many studies estimate that between 2 and 9.5 percent of all school-age children worldwide have ADHD; researchers have identified it in every nation and culture they have studied. What is more, the condition, which was once thought to ease with age, can persist into adulthood. For example, roughly two thirds of 158 children with ADHD my colleagues and I evaluated in the 1970s still had the disorder in their twenties. And many of those who no longer fit the clinical description of ADHD were still having significant adjustment problems at work, in school or in other social settings.

To help children (and adults) with ADHD, psychiatrists and psychologists

must better understand the causes of the disorder. Because researchers have traditionally viewed ADHD as a problem in the realm of attention, some have suggested that it stems from an inability of the brain to filter competing sensory inputs, such as sights and sounds. But recently scientists led by Joseph A. Sergeant of the University of Amsterdam have shown that children with ADHD do not have difficulty in that area; instead they cannot inhibit their impulsive motor responses to such input. Other researchers have found that children with ADHD are less capable of preparing motor responses in anticipation of events and are insensitive to feedback about errors made in those responses. For example, in a commonly used test of reaction time, children with ADHD are less able than other children to ready themselves to press one of several keys when they see a warning light. They also do not slow down after making mistakes in such tests in order to improve their accuracy.

The Search for a Cause

No one knows the direct and immediate causes of the difficulties experienced by children with ADHD, although advances in neurological imaging techniques and genetics promise to clarify this issue over the next five years. Already they have yielded clues, albeit ones that do not yet fit together into a coherent picture.

Imaging studies over the past decade have indicated which brain regions might malfunction in patients with ADHD and thus account for the symptoms of the condition. That work suggests the involvement of the prefrontal cortex, part of the cerebellum, and at least two of the clusters of nerve cells deep in the brain that are collectively known as the basal ganglia [see *illustration on page 69*]. In a 1996 study F. Xavier Castellanos, Judith L. Rapoport and their colleagues at the National Institute of Mental Health found that the right prefrontal cortex and two basal ganglia called the caudate nucleus and the globus pallidus are significantly smaller than normal in children with ADHD. Earlier this year Castellanos's group found that the vermis region of the cerebellum is also smaller in ADHD children.

The imaging findings make sense because the brain areas that are reduced in size in children with ADHD are the very ones that regulate attention. The

right prefrontal cortex, for example, is involved in "editing" one's behavior, resisting distractions and developing an awareness of self and time. The caudate nucleus and the globus pallidus help to switch off automatic responses to allow more careful deliberation by the cortex and to coordinate neurological input among various regions of the cortex. The exact role of the cerebellar vermis is unclear, but early studies suggest it may play a role in regulating motivation.

What causes these structures to shrink in the brains of those with ADHD? No one knows, but many studies have suggested that mutations in several genes that are normally very active in the prefrontal cortex and basal ganglia might play a role. Most researchers now believe that ADHD is a polygenic disorder—that is, that more than one gene contributes to it.

Early tips that faulty genetics underlie ADHD came from studies of the relatives of children with the disorder. For instance, the siblings of children with ADHD are between five and seven times more likely to develop the syndrome than children from unaffected families. And the children of a parent who has ADHD have up to a 50 percent chance of experiencing the same difficulties.

The most conclusive evidence that genetics can contribute to ADHD, however, comes from studies of twins. Jacquelyn J. Gillis, then at the University of Colorado, and her colleagues reported in 1992 that the ADHD risk of a child whose identical twin has the disorder is between 11 and 18 times greater than that of a nontwin sibling of a child with ADHD; between 55 and 92 percent of the identical twins of children with ADHD eventually develop the condition.

One of the largest twin studies of ADHD was conducted by Helene Gjone and Jon M. Sundet of the University of Oslo with Jim Stevenson of the University of Southampton in England. It involved 526 identical twins, who inherit exactly the same genes, and 389 fraternal twins, who are no more alike genetically than siblings born years apart. The team found that ADHD has a heritability approaching 80 percent, meaning that up to 80 percent of the differences in attention, hyperactivity and impulsivity between people with ADHD and those without the disorder can be explained by genetic factors.

Nongenetic factors that have been linked to ADHD include premature birth, maternal alcohol and tobacco

Diagnosing ADHD

Psychiatrists diagnose attention-deficit hyperactivity disorder (ADHD) if the individual displays six or more of the following symptoms of inattention or six or more symptoms of hyperactivity and impulsivity. The signs must occur often and be present for at least six months to a degree that is maladaptive and inconsistent with the person's developmental level. In addition, some of the symptoms must have caused impairment be-

fore the age of seven and must now be causing impairment in two or more settings. Some must also be leading to significant impairment in social, academic or occupational functioning; none should occur exclusively as part of another disorder. (Adapted with permission from the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders*. © 1994 American Psychiatric Association.)

INATTENTION

- Fails to give close attention to details or makes careless mistakes in schoolwork, work or other activities
- Has difficulty sustaining attention in tasks or play activities
- Does not seem to listen when spoken to directly
- Does not follow through on instructions and fails to finish schoolwork, chores or duties in the workplace
- Has difficulty organizing tasks and activities
- Avoids, dislikes or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork)
- Loses things necessary for tasks or activities (such as toys, school assignments, pencils, books or tools)
- Is easily distracted by extraneous stimuli
- Is forgetful in daily activities

HYPERACTIVITY AND IMPULSIVITY

- Fidgets with hands or feet or squirms in seat
- Leaves seat in classroom or in other situations in which remaining seated is expected
- Runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, subjective feelings of restlessness)
- Has difficulty playing or engaging in leisure activities quietly
- Is "on the go" or acts as if "driven by a motor"
- Talks excessively
- Blurts out answers before questions have been completed
- Has difficulty awaiting turns
- Interrupts or intrudes on others

LISA BURNETT

use, exposure to high levels of lead in early childhood and brain injuries—especially those that involve the prefrontal cortex. But even together, these factors can account for only between 20 and 30 percent of ADHD cases among boys; among girls, they account for an even smaller percentage. (Contrary to popular belief, neither dietary factors, such as the amount of sugar a child consumes, nor poor child-rearing methods have been consistently shown to contribute to ADHD.)

Which genes are defective? Perhaps those that dictate the way in which the brain uses dopamine, one of the chemicals known as neurotransmitters that convey messages from one nerve cell, or neuron, to another. Dopamine is secreted by neurons in specific parts of the brain to inhibit or modulate the activity of other neurons, particularly those involved in emotion and movement. The movement disorders of Parkinson's disease, for example, are caused by the death of dopamine-secreting neurons in a region of the brain underneath the basal ganglia called the substantia nigra.

Some impressive studies specifically implicate genes that encode, or serve as the blueprint for, dopamine receptors and transporters; these genes are very active in the prefrontal cortex and basal ganglia. Dopamine receptors sit on the surface of certain neurons. Dopamine delivers its message to those neurons by

binding to the receptors. Dopamine transporters protrude from neurons that secrete the neurotransmitter; they take up unused dopamine so that it can be used again. Mutations in the dopamine receptor gene can render receptors less sensitive to dopamine. Conversely, mutations in the dopamine transporter gene can yield overly effective transporters that scavenge secreted dopamine before it has a chance to bind to dopamine receptors on a neighboring neuron.

In 1995 Edwin H. Cook and his colleagues at the University of Chicago reported that children with ADHD were more likely than others to have a particular variation in the dopamine transporter gene *DAT1*. Similarly, in 1996 Gerald J. LaHoste of the University of California at Irvine and his co-workers found that a variant of the dopamine receptor gene *D4* is more common among children with ADHD. But each of these studies involved 40 or 50 children—a relatively small number—so their findings are now being confirmed in larger studies.

From Genes to Behavior

How do the brain-structure and genetic defects observed in children with ADHD lead to the characteristic behaviors of the disorder? Ultimately, they might be found to underlie impaired behavioral inhibition and self-

control, which I have concluded are the central deficits in ADHD.

Self-control—or the capacity to inhibit or delay one's initial motor (and perhaps emotional) responses to an event—is a critical foundation for the performance of any task. As most children grow up, they gain the ability to engage in mental activities, known as executive functions, that help them deflect distractions, recall goals and take the steps needed to reach them. To achieve a goal in work or play, for instance, people need to be able to remember their aim (use hindsight), prompt themselves about what they need to do to reach that goal (use forethought), keep their emotions reined in and motivate themselves. Unless a person can inhibit interfering thoughts and impulses, none of these functions can be carried out successfully.

In the early years, the executive functions are performed externally: children might talk out loud to themselves while remembering a task or puzzling out a problem. As children mature, they internalize, or make private, such executive functions, which prevents others from knowing their thoughts. Children with ADHD, in contrast, seem to lack the restraint needed to inhibit the public performance of these executive functions.

The executive functions can be grouped into four mental activities. One is the operation of working memory—holding information in the mind while working on a task, even if the original

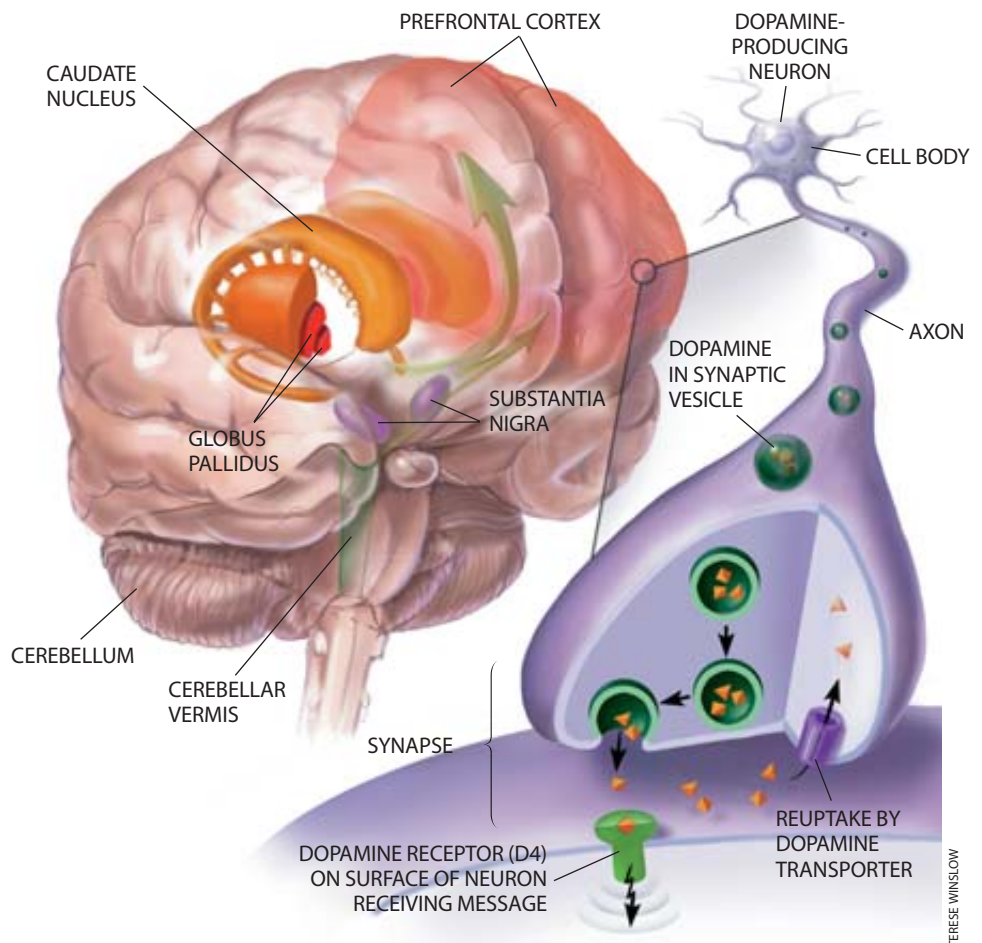
BRAIN STRUCTURES affected in ADHD use dopamine to communicate with one another (*green arrows*). Genetic studies suggest that people with ADHD might have alterations in genes encoding either the D4 dopamine receptor, which receives incoming signals, or the dopamine transporter, which scavenges released dopamine for reuse. The substantia nigra, where the death of dopamine-producing neurons causes Parkinson's disease, is not affected in ADHD.

stimulus that provided the information is gone. Such remembering is crucial to timeliness and goal-directed behavior: it provides the means for hindsight, forethought, preparation and the ability to imitate the complex, novel behavior of others—all of which are impaired in people with ADHD.

The internalization of self-directed speech is another executive function. Before the age of six, most children speak out loud to themselves frequently, reminding themselves how to perform a particular task or trying to cope with a problem, for example. ("Where did I put that book? Oh, I left it under the desk.") In elementary school, such private speech evolves into inaudible muttering; it usually disappears by age 10 [see "Why Children Talk to Themselves," by Laura E. Berk; *SCIENTIFIC AMERICAN*, November 1994]. Internalized, self-directed speech allows one to reflect to oneself, to follow rules and instructions, to use self-questioning as a form of problem solving and to construct "meta-rules," the basis for understanding the rules for using rules—all quickly and without tipping one's hand to others. Laura E. Berk and her colleagues at Illinois State University reported in 1991 that the internalization of self-directed speech is delayed in boys with ADHD.

A third executive mental function consists of controlling emotions, motivation and state of arousal. Such control helps individuals achieve goals by enabling them to delay or alter potentially distracting emotional reactions to a particular event and to generate private emotions and motivation. Those who rein in their immediate passions can also behave in more socially acceptable ways.

The final executive function, reconsti-



tution, actually encompasses two separate processes: breaking down observed behaviors and combining the parts into new actions not previously learned from experience. The capacity for reconstitution gives humans a great degree of fluency, flexibility and creativity; it allows individuals to propel themselves toward a goal without having to learn all the needed steps by rote. It permits children as they mature to direct their behavior across increasingly longer intervals by combining behaviors into ever longer chains to attain a goal. Initial studies imply that children with ADHD are less capable of reconstitution than are other children.

I suggest that like self-directed speech, the other three executive functions become internalized during typical neural development in early childhood. Such privatization is essential for creating visual imagery and verbal thought. As children grow up, they develop the capacity to behave covertly, to mask some of their behaviors or feelings from others. Perhaps because of faulty genetics or embryonic development, children with ADHD have not attained this ability and therefore display too much public behavior and speech. It is my asser-

tion that the inattention, hyperactivity and impulsivity of children with ADHD are caused by their failure to be guided by internal instructions and by their inability to curb their own inappropriate behaviors.

Prescribing Self-Control

If, as I have outlined, ADHD is a failure of behavioral inhibition that delays the ability to privatize and execute the four executive mental functions I have described, the finding supports the theory that children with ADHD might be helped by a more structured environment. Greater structure can be an important complement to any drug therapy the children might receive. Currently children (and adults) with ADHD often receive drugs such as Ritalin that boost their capacity to inhibit and regulate impulsive behaviors. These drugs act by inhibiting the dopamine transporter, increasing the time that dopamine has to bind to its receptors on other neurons.

Such compounds (which, despite their inhibitory effects, are known as psychostimulants) have been found to improve the behavior of between 70 and 90 per-

A Psychological Model of ADHD

A loss of behavioral inhibition and self-control leads to the following disruptions in brain functioning:

IMPAIRED FUNCTION	CONSEQUENCE	EXAMPLE
Nonverbal working memory	Diminished sense of time Inability to hold events in mind Defective hindsight Defective forethought	Nine-year-old Jeff routinely forgets important responsibilities, such as deadlines for book reports or an after-school appointment with the principal
Internalization of self-directed speech	Deficient rule-governed behavior Poor self-guidance and self-questioning	Five-year-old Audrey talks too much and cannot give herself useful directions silently on how to perform a task
Self-regulation of mood, motivation and level of arousal	Displays all emotions publicly; cannot censor them Diminished self-regulation of drive and motivation	Eight-year-old Adam cannot maintain the persistent effort required to read a story appropriate for his age level and is quick to display his anger when frustrated by assigned schoolwork
Reconstitution (ability to break down observed behaviors into component parts that can be recombined into new behaviors in pursuit of a goal)	Limited ability to analyze behaviors and synthesize new behaviors Inability to solve problems	Fourteen-year-old Ben stops doing a homework assignment when he realizes that he has only two of the five assigned questions; he does not think of a way to solve the problem, such as calling a friend to get the other three questions

LISA BURNETT

cent of children with ADHD older than five years. Children with ADHD who take such medication not only are less impulsive, restless and distractible but are also better able to hold important information in mind, to be more productive academically, and to have more internalized speech and better self-control. As a result, they tend to be liked better by other children and to experience less punishment for their actions, which improves their self-image.

My model suggests that in addition to psychostimulants—and perhaps antidepressants, for some children—treatment for ADHD should include training parents and teachers in specific and more effective methods for managing the behavioral problems of children with

the disorder. Such methods involve making the consequences of a child's actions more frequent and immediate and increasing the external use of prompts and cues about rules and time intervals. Parents and teachers must aid children with ADHD by anticipating events for them, breaking future tasks down into smaller and more immediate steps, and using artificial immediate rewards. All these steps serve to externalize time, rules and consequences as a replacement for the weak internal forms of information, rules and motivation of children with ADHD.

In some instances, the problems of ADHD children may be severe enough to warrant their placement in special education programs. Although such

programs are not intended as a cure for the child's difficulties, they typically do provide a smaller, less competitive and more supportive environment in which the child can receive individual instruction. The hope is that once children learn techniques to overcome their deficits in self-control, they will be able to function outside such programs.

There is no cure for ADHD, but much more is now known about effectively coping with and managing this persistent and troubling developmental disorder. The day is not far off when genetic testing for ADHD may become available and more specialized medications may be designed to counter the specific genetic deficits of the children who suffer from it.

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Further Reading

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Learning to Focus

A few simple tricks can help children (and adults) improve their concentration powers

BY CHARMAINE LIEBERTZ

“YOU HAVE TO CONCENTRATE!” Who among us never heard that exhortation in grade school or from our parents? Of course, it is genuinely difficult for children to ignore distractions and dedicate themselves to a task at hand. Yet school counselors and cognitive therapists see the inability to concentrate as a widespread learning problem. Some straightforward steps can improve concentration power—for students and adults.

Parents can first help children learn how to concentrate by being good role models. If you are working on an assignment or project, show your children what you are doing and how you will break the task into manageable pieces. Then let them know why you do not want to be disturbed.

When it is the child’s time to work, show them how to implement a few simple rules. Most important is to create an optimal work environment—a quiet space devoid of distractions such as background music, television images, conversations, toys, and sibling and pet traffic. The stimulus filters in the brain—the thalamus and the limbic system—are not always able to screen out such disturbances.

If a task is complex, such as a huge jigsaw puzzle or a time-consuming construction project for school, help children figure out how to divide up the work. Explain the value of focusing and completing one piece at a time, instead of trying to grapple with the entire job at once. After the student is under way, he or she may be quite content to work independently, converting what was just learned into his or her own persistence. Remember that a child’s capacity to concentrate is considerably less than that of an adult, so adjust your expectations and possible criticism accordingly.

Quiet Rules

Other tactics, noted below, will also be handy. Adults might consider adopting the measures as well. Too often we fail to follow such simple and time-honored tips. We allow ourselves to be bombarded with interruptions and check e-mail too frequently, believing we can juggle many tasks simultaneously. It is an illusion to think that we can parcel out our attention so finely. Recent research has demonstrated that our brains really can’t handle multitasking effectively—doing different things in

Balance the Senses

Our capacity to focus and think develops primarily during the first 10 years of life, becoming firmly established as a result of mental, emotional and motor experiences. The human brain learns only gradually how to filter the flood of incoming stimuli and select the most important information.

But a boy or girl who sits constantly in front of a television or computer game shapes his or her neural networks differently than a peer who primarily plays physical games with friends or reads books. In today’s information society, a child’s sight and hearing senses are often overstimulated, while other fundamental channels of perception such as touch may remain underdeveloped. This imbalance can prevent children from learning how to process information correctly, making it even harder for them to concentrate. Parents and educators should therefore make sure that children are exposed to a well-balanced sensory palette early on. —C.L.

parallel, with the same level of concentration toward each demand [see “The Limits of Multitasking,” *SCIENTIFIC AMERICAN MIND*, Premier Issue, 2004].

Motivation. Before beginning a work session, ask yourself why you want to take on the particular task. Your motivation will increase as soon as you are clear about the goal and payoff, which in turn will keep you focused. Concentration disorders in children are often motivational problems in disguise. Consider that many students claim it is hard to memorize vocabulary lists, even though they have no trouble retaining the complicated names of Pokémon characters or dinosaurs.

Emotional tugs. Tumultuous feelings can readily divert your attention. Try listing all these feelings on a piece of scrap paper—just writing down the words can clear the distractions from your mind.

Diet. When our brains work hard, they burn large quantities of the sugar glucose. A steady nutritional supply throughout the day, from more frequent but smaller meals of foods such as fruit, yogurt and full-grain bread, may improve your focus better than the blood-sugar spikes and dips associated with heavy meals and long fasts in between, especially if you are consuming sugary drinks, cakes and white breads.

Physical activity. Frequent physical activity increases oxygen and glucose supplies to the brain. If you have been sitting at a desk for too long and feel you are fading mentally, get up and take a walk.

Praise. After a productive spell of concentration, praise yourself. Even more so, praise your child. The brain’s reward centers will produce dopamine, eliciting a sense of happiness, which will encourage even greater focus next time.

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Games to Improve Concentration

Story detective One person in a small group tells or reads a story containing numerous details. She then asks a series of questions: What animals, persons, objects and colors were mentioned? Where was the house that was robbed located? What time did the main character come home? A logic error can be built into the story, too; the first person to recognize it gets to tell the next story.

Concentration Six to eight players stand in a circle. One player displays a body movement. The next player repeats it, adding another movement. Each subsequent player repeats the prior movements and adds a new element. If that seems too easy, create a movement and sound simultaneously; for example, nod and whistle.

Restaurant One person, the waiter, approaches a group of two or three others and mentally notes orders that those players place, choosing from objects visible in the room (one magazine, two red pencils, one lamp). When the waiter remembers the orders successfully, another player takes over that role. —C.L.